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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS.

An Asterisk (*) denotes an illustrated article.

OFFICIAL NOTICES—
- Thirty-Second Annual Meeting, New England Association of Gas Engineers 77
- First Annual Meeting, Wisconsin Gas Association 77
- Ohio Gas Light Association—Novelty Advertising Department.... 77

EDITORIALS—
- Briefly Told 77
  - A Just Decision—Notes.
- Combustion in Gas Producers and Benches, by Mr. Robert W. Prosser 78
- *Explosive Gas Mixtures, by Dr. H. Bunte 81
- Electric Gas Lamps and Gas Electrical Resistance Phenomena, by Mr. Peter C. Hewitt. 83
- Technical Education 84
- The Functions of Arresters and Choke Coils 85
- Stoppages Caused by Naphthaline 86
- The Photographophone or Electric Arc Kinematograph 87

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 88

Changes at Laconia, N. H.—Contract for the Western Gas Construction Company—Another Company for Seattle, Wash.—Something from Paris, Ky.—Gov. Crane's Recommendation—To Liquidate the Brampton (Ont.) Company—Annual Meeting, Cranford, N. J.—Hints from Norfolk, Va.—More Changes in the Middletown (N. Y.) District—Payment on Franchise Account, Nashville, Tenn.—Opposition Company for Rochester, N. Y.—Annual Meeting, Lebanon, Pa.—Manager Learned's New Offices—Proposed Works for Holland, Mich.—Collinwood, Ohio Wants Gas—Annual Meeting, Nashville, Tenn.—The Pontiac (Mich.) Company Reorganized—Increase in Capital, Cincinnati, O.—New Holder, Los Angeles, Cal.—Annual Meeting, Omaha, Neb.—An Embezzler—Annual Meeting Peoples Co., Cleveland, O.—And Other Items.

- The Market for Gas Securities 90

[OFFICIAL NOTICE.]

Thirty-Second Annual Meeting, New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF THE SECRETARY,
NEW BEDFORD, MASS., Dec. 26th, 1901.

The Thirty-Second Annual Meeting of the New England Association of Gas Engineers will be held in Boston, February 19 and 20, 1902. The headquarters will be in Youngs' Hotel as usual; but, owing to the increased attendance at the meetings, which necessitates the securing of a larger assembly room, the sessions will be held in the Parker House.

A lively interest in the meeting is being shown by members, and the programme in detail will be issued later. W. W. GIFFORD, Sec'y.

[OFFICIAL NOTICE.]

First Annual Meeting, Wisconsin Gas Association.

RACINE, WIS., Jan. 15th, 1902.

The First Annual Meeting of the Wisconsin Gas Association will be held in Madison, Wis., on Wednesday and Thursday, the 12th and 13th days of February. The headquarters of the Association will be at "The Park," where accommodations can be had at the rate of $3 per day, and rooms with baths for $4 per day.

Unless advised to the contrary the Association meetings will be held in "The Park." HENRY H. HYDE, Secretary,
Wisconsin Gas Association.

[OFFICIAL NOTICE.]

Ohio Gas Light Association—Novelty Advertising Department.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF THE SECRETARY,
DELAWARE, O., Dec. 24, 1901.

Members of the Ohio Gas Light Association are earnestly requested to send to Mr. B. W. Perkins, South Bend, Ind., any contribution they may have for the Novelty Advertising Department of the Association. This is a most favorable time, just at the close of the season, when the many successful methods of advertising tried during the year are still fresh in the minds of those who used them. T. C. JONES, Sec'y.

BRIEFLY TOLD.

A JUST DECISION.—Last week we published the text of the decision of the Massachusetts Board of Gas and Electric Light Commissioners, in the instance of the appeal to that body, by Mayor French, of Gloucester, Mass., that the Gloucester Gas Light Company be obliged to put its selling rate to ordinary consumers at $1 per 1,000 cubic feet. While the decision of the Commissioners is plain to the point of requiring no explanation, in that it really and clearly explains itself, it might be as well to note that it furnishes an excellent reason in support of the thought that a semi-judicial commission, to supervise the manufacturing industries of a State, is greater and more efficacious in its results on

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and for such industries than the entire legal system, from the lowest court to the highest. The immediate circumstances at Gloucester, prior to the agitation for a lower gas rate, were about like this. In due time Gloucester elected a new mayor, in the person of a gentleman named French. His issue was reform, and those behind him, or who believed they "propelled" him to office, thought and said that fairly prosperous local concerns, who did not deal in fish, should be "salted." One such concern was the Gloucester Gas Light Company, a corporation which, according to the language of the Commissioners' decision, had been and was selling gas at prices "the lowest made by any Company of equal size in the State." The Mayor and his "netters," blind as they were to the real facts at issue, "ordered" the Company before the Commissioners, and in due time the hearing was had. During the taking of evidence Mayor French and his aids were unable to testify that the service of the Company was bad or even indifferent; in fact, some of the speeches in support of the claim for cheaper gas in effect went to prove that the Company was well managed, that it was heedful of the needs of the residents, that it was a good employer of labor, and that it paid its debts, out of which latter the municipality of Gloucester was a free sharer, in the instance of tax collections of one sort or another. With such a beginning on the part of the accuser, the accused had only to tell the truth, which the Company's attorneys and its officers did in straightforward fashion. The Company's accounts and its actual standing were freely put in evidence, and when the case was taken under advisement by the Commissioners, Mayor French and his "netters" would gladly have asked the trial judges to consider that no hearing had been asked for, since they knew quite well that their charges were not according to the facts. The decision of the Commissioners that gas on private account in Gloucester, at the rate of $1.20 per 1,000, and at $1 per 1,000 for public use, is not excessive will be acquiesced in by every practical gas man in the country, and the decision will also be acclaimed as an evidence that State boards in supervising charge of manufacturing industries, may be safely counted on to in the long run maintain the distinction between public clamor and public right. For it may not be truthfully denied that at the outset all the public clamor was with Mayor French and against the Gloucester Gas Light Company. Now Mr. Coffin and his associates may go on serenely with the betterments which they have been contemplating for the further benefit of those to whom they have reasonably and successfully catered for many years.

NOTES.—Mayor Taylor, of Richmond, Va., has agreed to the resolution which appropriates the sum of $14,000 for suitable enlargement of the main system of the City Gas Works.——In our item columns brief mention is made of the incorporation of an opposition lighting concern for Rochester, N. Y., the baptismal appellation of which is the Municipal Gas and Electric Company. The executive management of the concern, in addition to that given in the item, is as follows: President, C. K. G. Billings, of New York; Vice-President, Horace C. Brewster, of Rochester; Secretary and Treasurer, Charles H. Werner, of New York.——Mr. Edward Davis Smith, Secretary and Treasurer of the Reading (Pa.) Gas Company since 1857 (its properties are now operated under leasehold by the Consumers Gas Company of Reading), died at his home in Reading the morning of the 12th inst. He was in his 86th year, having been born in New Holland, Lancaster County, Pa., March 2, 1816.——We understand that the Loomis-Pettibone Company of New York is to construct a gas plant in Monterey, Mexico. The estimated "cost" of the construction is put at $500,000. Where are the coke oven men?——Mr. J. Warren Lamb and Gottfried Falkenstein, of Cooperstown, N. Y., acting in conjunction with Messrs. F. Blanchard, A. C. Blanchard and George L. Blanchard, of Monpelier, Vt., have asked for a franchise to operate a gas plant in Montpelier under the title of the Capital City Gas Company. One portion of their covenant is that "It is agreed that the average price to be charged shall not exceed $2 per 1,000 cubic feet for small consumers, and $1.75 to larger consumers, and the said Gas Company agrees to furnish gas to any bnildings, or parts thereof, used for municipal purposes exclusively, for $1 per 1,000 cubic feet." The projectors agree to have the manufacturing and distributing plants completed within 18 months from the signing and acceptance of the franchise.——The authorities of Haverhill, Mass., have finally agreed to a settlement of their debt for gas supplied by the Haverhill Gas Company, the dispute over which has existed since 1899. The Company insisted on obtaining $1 per 1,000, and the city declined to offer more than 80 cents—this figure was the compulsory one ordered by the Board of Gas and Electric Light Commissioners, and the contention over the legality of such rate is still before the courts—but the compromise was on the basis of 90 cents.

Combustion in Gas Producers and Benches.

[Prepared for the JOURNAL, by MR. ROBERT W. PROSSER.]

Introduction.—The following data and speculations on the working of gas producers, when used for carbonizing coal in the manufacture of gas, were made by the writer for his own use, but it is believed that they will be of interest to others, in showing the effects of various methods of working, and the advantages and disadvantages of each.

The speculations refer to the possibility of improvement in different directions, and to the investigations of some ideas that have been advanced in the past in a rather tentative manner, but which have never been pushed to a conclusion.

The equivalents used in the calculations are as follows:

The thermal unit is the B. T. U. of 1 pound of water raised 1° F.; temperatures are in degrees Fahrenheit; 1 ton equals 2,240 pounds.

Combustion.

1 pound of carbon to CO_2	=	14,500 B. T. U.
" " CO	=	4,290 "
1 pound H and O to steam	=	5,746 "

Specific Heat at Constant Pressure.

Unit weight of water	=	1.000
" " steam	=	.480
" " air	=	.237
" " oxygen	=	.217
" " nitrogen	=	.244
" " hydrogen	=	3.409
" " carbonic oxide	=	.245
" " carbonic acid	=	.216

The composition of air is assumed to be 21 per cent. N and 79 per cent. O, and the weight of a cubic foot 534.6 grains. The combustion values of gases and their weights are calculated from those given by Prof. Julius Thomsen. Volumes are at 60° and atmospheric pressure of 14.7 pounds, unless otherwise stated.

The heat required to carbonize 1 ton of gas coal, according to the very best results of different authorities, varies from 2,800,000 B. T. U. to 3,000,000 B. T. U., or equal to nearly 10 per cent. of the total heat of the coal. Gas coal generally produces about two-thirds of its weight of coke, or, say, for 1 ton of coal, 1,500 pounds of coke. A fair quality should contain 12,700 B. T. U. per pound, and if 15 per cent. is used in the furnace, 1 ton of coal will require 225 pounds of coke, or 2,857,500 B. T. U.. for carbonization.

Mr. C. F. Prichard's experiments[1] give the value of coke as 13,469 B. T. U., or 3,030,500 B. T. U. per ton of coal carbonized, under the above conditions.

Dr. Schniewind[2] gives 2,884,000 B. T. U. and 2,974,000 B. T. U. as the heat used to carbonize 1 ton of coal in Otto-Hoffmann ovens, which is rather remarkable for retort ovens; but as the heat units in salable gas are worth about 12 times as much as heat units in coke at ordinary prices, the economy of using gas for firing the ovens would appear to be doubtful. Dr. Schniewind gives the heat value of coke as 12,645 B. T. U. per pound.

These results may be taken as the very best in the United States, but the average of good practice will be nearer 3,500,000 B. T. U. per ton.

Comparisons of the fuel used for carbonization in different benches are, however, of little value, unless the same coal is used in each, as the theoretical amount of heat required is dependent, not only on the proportion between the fixed carbon and volatile matter contained in the coal, but also on the amount of latent heat absorbed by equal quantities of volatile matter, which is not a constant quantity owing to differences in the chemical combination of the hydrogen and carbon in the coal.

For this reason all formulas based on, or which are modifications of, that of Dulong are liable to error, though generally giving, with the same class of coal, remarkably close approximations to truth.

Judging from the ease with which cannel coal is carbonized, though containing a very large proportion of volatile matter, its latent heat of vaporization must be very small.

Where the fuel is calculated as a percentage of the coke made, the percentage used with such volatile coal is excessive, as the weight of coke produced per ton is diminished.

The heat units in the materials resulting from the carbonization of 100 pounds of gas coal are about as follows:

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1. AMERICAN GAS LIGHT JOURNAL, Nov. 18, 1901, p. 807.
2. *Prog. Age*, Oct. 15, 1901.

510 feet gas, 675 B. T. U.	344,250 B. T. U.
66⅔ pounds coke, 13,469 B. T. U.	897,933 "
6 pounds tar, 15,700	94,200 "
Ammonia, sulphur, etc., and loss	93,617 "
	1,430,000 "

The heat value of a ton of gas coal is taken at 32,000,000 B. T. U., or 14,300 per pound.

The heat value of the constituents of coal is greater after carbonization than before, as the latent heat of liquefaction and vaporization of the gas, tar and moisture has been furnished by the producer, and not at the expense of the coal in the retorts; but those products which condense after vaporization can only be credited with the latent heat of liquefaction, as that of vaporization is all lost, as is also the sensible heat of all the products of carbonization.

These losses appear to always exceed the gains, as the total heat of the coal is never accounted for in the products of carbonization.

The following tables show the conditions in running producers with 30, 40, 50 and 60 per cent. of steam per pound of carbon consumed in the producer, the temperature of the gas, supposing no loss by radiation, and the chimney loss by waste gases at various temperatures.

These calculations assume that the producer gases consist entirely of CO, N and H, and that the waste gases are entirely CO_2, N and steam. They must be corrected for defective working of the producer and for unconsumed or other gases in the waste gases, and also for production of hydrogen or hydrocarbons from the fuel and for the ash in same.

Producer gases frequently contain from 4 per cent. to 10 per cent. of CO_2 and also uncombined steam, and the waste gases from 1 per cent. to 8 per cent. of CO, O and other gas, and also the uncombined steam from the producer.

The producer is supposed to be furnished with steam at atmospheric pressure, the latent heat of vaporization of which, as also the sensible heat of water from 60°, has been supplied by the waste gases.

Producer Gases.

With 60 per cent. steam—

Pounds.		Pounds.	Cubic Feet.	Cubic Feet.
.6	steam	.0666 ... H		12.62
		.5333 ... O ... 6.31	CO	
1.0	carbon	.4000 ... C ... 6.31		12.62
		.6000 ... C ... 9.46	CO	
3.4419	air	.8000 ... O ... 9.46		18.93
		2.6419 ... N		35.59
5.0419		5.0419		79.76

Specific gravity, .82. Specific heat, .286 per pound.

With 50 per cent. steam—

Pounds.		Pounds.	Cubic Feet.	Cubic Feet.
.5	steam	.0555 ... H		10.52
		.4444 . O ... 5.26	CO	
1.0	carbon	.3333 .. C ... 5.26		10.52
		.6666 ... C ... 10.52	CO	
3.8243	air	.8888 ... O ... 10.52		21.04
		2.9355 ... N		39.55
5.3243		5.3243		81.63

Specific gravity, .85. Specific heat, .277 per pound.

With 40 per cent. steam—

Pounds.		Pounds.	Cubic Feet.	Cubic Feet.
.4	steam	.0444 ... H		8.41
		.3555 .. O ... 4.20	CO	
1.0	carbon	.2666 ... C ... 4.20		8.41
		.7333 ... C ... 11.56	CO	
4.2061	air	.9777 ... O ... 11.56		23.12
		3.2284 ... N		43.49
5.6061		5.6061		83.43

Specific gravity, .88. Specific heat, .270 per pound.

With 30 per cent. steam—

Pounds.		Pounds.	Cubic Feet.	Cubic Feet.
.3	steam	.0333 ... H		6.31
		.2666 ... O ... 3.15	CO	
1.0	carbon	.2000 ... C ... 3.15		6.31
		.8000 ... C 12.62	CO	
4.5891	air	1.0666 ... O ... 12.62		25.24
		3.5225 ... N		47.45
5.8891		5.8891		85.31

Specific gravity, .90. Specific heat, .262 per pound.

As 1 pound of carbon will finally require the same quantity of air for its complete combustion, whether steam has been used or not, and as this air will be composed of 2⅔ pounds O (31.56 feet) and 8.812 pounds of N (118.71 feet) the total quantity required will be 150.27 feet, weighing 11.478 pounds.

The O, combining with carbon to form CO_2, will absorb 1 pound of carbon without change of volume, making weight of CO_2 equal to 3⅔ pounds. The volume of waste gases (without the steam) will, therefore, be the same as that of the air employed.

If to the N and CO_2 is added the steam used, the total will be the waste gases.

The volumes of waste gases are calculated at atmospheric pressure and a temperature of 212°, as at this and higher temperatures steam acts as a perfect gas, or nearly so, while at lower temperatures the greater part is condensed.

The specific gravity and also the volume are given at 60°, supposing steam to act as a perfect gas at this temperature and pressure. This imaginary volume may be used in all calculations where the resulting temperature is over 212°.

Waste Gases.

With 60 per cent. steam—

	Weight in Pounds.	Volumes in Cubic Feet. at 60°	at 212°
Nitrogen	8.812	118.71	153.41
Carbonic Acid	3.666	31.56	40.78
	12.478	150.27	194.19
Steam	.600	12.62	16.31
	13.078	162.89	210.50

Specific heat, .247. Specific gravity, 1.05.

With 50 per cent. steam—

	Weight in Pounds.	Volumes in Cubic Feet. at 60°	at 212°
N and CO_2	12.478	150.27	194.19
Steam	.500	10.52	13.60
	12.978	160.79	207.79

Specific heat, 2.45. Specific gravity, 1.06.

With 40 per cent. steam—

	Weight in Pounds.	Volumes in Cubic Feet. at 60°	at 212°
N and CO_2	12.478	150.27	194.19
Steam	.400	8.42	10.88
	12.878	158.69	205.07

Specific heat, .243. Specific gravity, 1.07.

With 30 per cent. steam—

	Weight in Pounds.	Volumes in Cubic Feet. at 60°	at 212°
N and CO_2	12.478	150.27	194.19
Steam	.300	6.31	8.15
	12.778	156.58	202.34

Specific heat, .241. Specific gravity, 1.07.

The reactions in the producer have been assumed to be very simple, and that the steam is all decomposed, the H being set free and the O uniting with the carbon to form CO, with mathematical precision.

Unfortunately these are not strictly the facts, as we know that the formation of CO is preceded by the production of CO_2, which is subsequently decomposed.

Practically there is always some CO_2 in the producer gases, but whether this is part of that originally formed, or whether it has been decomposed and subsequently reformed, we do not know, nor whether it is a necessity, or only the result of imperfect working of the producer; and the steam in the producer gas may have simply passed through the fire, or it may have been decomposed and recomposed in its passage.

Though we cannot follow these reactions, we can tell the amount of heat produced, by an analysis of the producer gas and its temperature, and by knowing the constituents of the fuel and the quantity used.

The cause of the secondary reaction resulting in the formation of CO, is not known, but as it is best produced by a deep fire in a state of intense combustion, it would seem to point to dissociation by heat as being the explanation.

CO is, however, formed by any carbon flame having a deficient supply of O, which fact apparently negatives this hypothesis.

The quantity of heat (per pound of carbon consumed) which is contained in the waste gases at 500°, 1,000°, 1,500° and 2,000°, above normal of 60°, will be in B.T.U. as follows:

	Temperature of Waste Gases. 500°	1,000°	1,500°	2,000°	Per Ct. Vol. of Steam.
With 60 per cent. steam	2,243	3,857	5,472	7,087	7.7
" 50 " "	2,114	3,704	5,296	6,887	6.5
" 40 " "	1,985	3,552	5,119	6,686	5.3
" 30 " "	1,857	3,400	4,943	6,486	4.0
" 0 " "	1,471	2,942	4,413	5,884	0

The last column shows the per cent. volume of steam in the waste gases, and the last line shows the quantity of heat in the waste gases, with no steam.

The figures in this table are made up of the sensible heat of the water from 60° to 212°, the latent heat of vaporization of water at 212°, the sensible heat of the steam from 212° to the temperature given, and the sensible heat of the CO_2 and N from 60° to the temperature given.

The quantity of heat returned to the bench by heating the secondary air 1,000° and the primary air 500° above normal, and vaporizing the water at atmospheric pressure, in the case of the producer using 50 per cent. steam, would be 2,826 B.T.U. As the temperature of the waste gases at the entrance of the waste flue must be the same as the temperature of the bench, or upwards of 2,000°, there is a superabundance of heat in the waste gases for all purposes of recuperation.

Every pound of water at 60° used in the generator carries away from the bench 1,525 and 2,005 B. T. U. with the waste gases escaping at 1,000° to 2,000° above normal.

This is made up as follows:

	1,060°	2,060°
Sensible heat from 60° to 212°	152	152
Latent heat of vaporization	966	966
Sensible heat of steam.. $\begin{cases} 1,060°-212° = 848 \times .48 \\ 2,060°-212° = 1,848 \times .48 \end{cases}$	407	887
	1,525	2,005

Where the sensible and latent heat of the steam at 212° are furnished by the waste gases, the only loss is in the sensible heat of the steam carried away by the waste gases, and part of this may be recovered.

This loss in the above four cases, per pound of carbon consumed, is:

	1,060°	2,060°
60 per cent. steam	244	532
50 " "	203	443
40 " "	163	355
30 " "	122	266

But the effect of the increased volume of steam in cooling or reducing the intensity of combustion will be quite appreciable.

Take the case of no steam being used, and that the combustion temperature is 4,929° above a normal of say 212°. As ordinarily calculated this temperature will be reduced as follows:

Products of Combustion of 1 *Pound of Carbon.*

Without steam...	8.812 lbs.	N	×.244	2.150	
	3.666 "	CO_2	×.216	.792	
	12.478			2.942	×4,929°=14,500 B.T.U.
With steam.....	.5 "	steam	×.480	.240	
	12.978			3.182	×4,557°=14,500 B.T.U.
					372°

Showing a loss by the use of 50 per cent. steam of 372°.

For reasons hereafter given the intensity of combustion will not be so great as that assumed, which was taken because it just accounts for all the heat in the carbon (14,500 B.T.U.)

The latent heat taken from the waste gases by the steam used per pound of carbon is:

60 per cent. steam	580 B.T.U.
50 " "	483 "
40 " "	386 "
30 " "	290 "

The latent heat of 1 pound of steam is 966 B.T.U.

It will be seen that the volume of the waste gas is practically twice that of the producer gas at the same temperature, and the volume of the primary air varies from 45 to 60 cubic feet per pound of carbon, depending on how much steam is admitted to the producer, but the total volumes of the producer gas, under the different conditions, only vary 7 per cent.

The volume at 60°, and weight of the primary and secondary air, required in each case will be as follows:

	Primary Pounds.	Air. Cu. Ft.	Secondary Pounds.	Air. Cu. Ft.
60 per cent. steam	3.442	45.05	8.036	105.22
50 " "	3.824	50.06	7.654	100.21
40 " "	4.206	55.05	7.272	95.22
30 " "	4.589	60.06	6.889	90.21
0 " "	5.739	75.13	5.739	75.13

The quantity of heat required for the decomposition of one pound of steam to H and O, is 5,756 B. T. U., which is taken from the producer fire, and the 4,290 B. T. U. produced by the combustion of one pound of carbon to CO must be reduced by the amount of heat used in decomposing the steam.

In the five cases given, the remaining heat, which goes to raise the temperature of the producer gases, will be—

	Available Heat.	Temp. Raised.
60 per cent. steam	836 B.T.U.	579°
50 per cent. "	1,412 "	956°
40 per cent. "	1,988 "	1,316°
30 per cent. "	2,563 "	1,659°
0 per cent. "	4,290 "	2,606°

This is supposing that no heat is lost by radiation, that there is no dissociation, and that the specific heat of gases is constant at all temperatures.

If .745 pound of steam is fed to the fire and all decomposed, it will just equal the heat of combustion of 1 pound carbon to CO, and is the greatest amount that can be (theoretically) used without extinguishing the fire.

Practically, more can be used, as part passes without decomposition, and if CO_2 is formed, the quantity can be very largely increased, as is shown by the Mond producer gas, which contains about 17 per cent. or 18 per cent. of CO_2, and which uses about 2½ pounds of superheated steam per pound of coal, but of which quantity less than 1 pound is decomposed.

In the case of a producer making 10 per cent. of CO_2, and using 50 per cent. of steam per pound of carbon, the available heat would be: 4,664 B. T. U., specific heat of gases .264; weight, 7.155 pounds; volume 100.54 feet; and temperature of gases would be raised 2,470°, from a normal of say 300°, which would bring it much above the melting point of cast iron. This percentage of CO_2 would completely consume 32 per cent. of the carbon.

It is not probable that any such heat is generated in a producer, working as this is assumed to be, as in addition to loss by radiation and reduction of temperature by increased specific heat, there is a loss of heat by steam passing through the producer without decomposition, and by dissociation, or the separation of compound gases at high temperatures, with a corresponding absorption of heat. These reductions will be considered in detail.

Radiation and Conduction.—Firebrick, which forms the envelope or covering of most furnaces, has a capacity for heat equal to about ⅓th that of water. Its power of conducting heat is stated to be as great as that of cast iron, and its ability to radiate heat is very great, in common with other materials having a rough and dull surface.

This latter property is apt to mislead in estimating its non-conducting power, as the fact of its being cool may be due to its non-conduction, or to its radiation exceeding its powers of conduction.

Data in regard to any of these properties are so conflicting that it is useless to give figures, which probably have different values with varying temperatures. At ordinary temperatures the metals are classed with the worst radiators.

The power of firebrick and red brick to conduct heat, where radiation is prevented, has been very forcibly shown to some gas managers by the burning of cap logs and piles beneath bench foundations, which in some cases has occurred at a depth of 6 feet below the grate bars of open fires, where the ground was dry; and in the carbonization of coal in clay retorts, of about double the thickness of the iron retorts formerly in use, which shows that as much gas can be made in clay retorts in the same time, and with the same furnace and expenditure of fuel, as in the old iron retorts.

This result has been attributed to the higher heats used with clay retorts, but it would not account for the same fuel being required, unless the conductivity and radiation of the clay retort were greater than cast iron, or were greatly increased by the high temperature.

A large part of the present reduction in fuel used is due to regeneration and the use of hot coke, and to improvements in bench settings.

By returns, made to the British Parliament, of the operation of 15 gas works in Great Britain, from 1834 to 1837, it was shown that the average consumption of coke in the benches was about 36 per cent. of that made, and the highest, about 61 per cent.

Some companies were using bituminous slack coal in the furnaces, and the gas made per ton varied from 6,500 feet to 9,500 feet. At this time iron retorts were used almost exclusively.

The transfer of heat from the outside to the inside of gas retorts, required in carbonization, is about 1,500 B.T.U. per square foot of outside surface per hour, or less than half that required per average square foot of heating surface, in the ordinary steam boiler.

In a good boiler this transfer is made with a difference of only 150°, between the waste gases and the internal temperature of the boiler.

Diathermancy, or the property possessed by some bodies of permitting the free and instantaneous passage of heat through them, is not confined to transparent bodies (Tyndall), and it may account for some of the loss of heat in firebrick furnaces.

Where a producer is situated inside the bench, the radiation must be very small, but as some of the most efficient producers are outside the bench, the loss from radiation must in either case be small.

In a perfectly working producer using 50 per cent. of steam, the temperature of the gases would, as previously stated, be about 1,000°, so that the radiation would not be very apparent in the final results, as if all were lost it would only amount to 10 per cent. of the whole value of the coke.

In the combustion in any direct fired furnace requiring great intensity, it has been the universal experience that the heat must be applied immediately after combustion, and that it is impossible to carry it any distance (with every precaution against radiation) without a great loss in intensity.

This is particularly the case with coke and anthracite coal, and other flameless combustibles, the intensity of combustion of which is extremely local, and is confined almost entirely to the fire itself.

That this loss is not entirely due to radiation of heat is now pretty well determined.

A curious fact bearing on radiation is that, in explosions of gases in closed vessels, the same temperature and pressure are attained in small vessels, as in large ones (Clerk) though the cooling surface of spheres (or any other vessels whose dimensions are increased proportionally in all directions) increases as the squares, while the capacities increase as the cubes of the respective diameters, thus apparently showing that the amount of cooling surface does not affect the temperature of explosion.

[To be Continued.]

Explosive Gas Mixtures.[1]

[Abstract Translation of a paper, read by Dr. H. BUNTE, of Carlsruhe, Germany, before the German Association of Gas and Water Engineers.]

Explosive gaseous mixtures are interesting from two different aspects, according as they produce useful or disastrous results. A mixture of gas and air, exploded in the gas engine, is a motive power; while, on the other hand, the explosive gaseous mixtures which occur in coal mines, where they are known as firedamp, are dangerous in the highest degree, as are also mixtures formed from coal gas and other combustible gases. Our knowledge of the behavior of such explosive mixtures is mainly derived from the researches on firedamp, with which the most renowned chemists have battled for upwards of a century. Davy, in 1815, published an account of his investigations which culminated in the invention of the safety lamp, which has since proved of such immense service to the mining industry. Bunsen published in 1858, the first impression of his work on methods of gas analysis, and thereby helped greatly to extend our knowledge of the nature of explosive gaseous mixtures. In 1883, Mallard and Le Chatelier dealt exhaustively with the combustion of such mixtures, and all later work on the subject stands in close relation to theirs. These dates mark the more important epochs in the history of the subject, which, however, has been treated by many other investigators. Nevertheless, there are many gaps in our knowledge of it; and it was with a view to filling some of them that the author undertook some new researches, with the assistance of Drs. Eitner and Trautwein. The data here recorded are based on the result of their researches.

A gas explosion is the result of a sudden combustion of a mixture of air and a combustible gas—such as, in particular, illuminating gas. The development of heat which results from the combustion expands the products of combustion; and they exert a pressure or shock on the encompassing walls, more or less severe according to the composition of the mixture and the nature of the gas. This pressure is applied in the gas engine in performing useful work; while it is also responsible for the destructive effects of unpremeditated gas explosions.

It is unnecessary to remind gas engineers that coal gas is not itself explosive, though the general public is convinced that a gasholder entails danger of explosion to the locality where it is. Clegg's demonstration, in a London gas works, nearly a century ago, before a Commission, of the inexplosiveness of coal gas, by knocking a hole in the side of a gasholder, and igniting the outflowing gas, might even now bring conviction when the question of danger of explosion from gasholders is under discussion in connection with the granting of concessions for gas supplies. It has also been proved, through the action of a criminal at Glasgow, that the contents of a gasholder are not exploded by the most powerful blasting agents; for dynamite there destroyed only ironwork, and the escaping gas ignited and burnt away. A similar experience has recently been reported from Cork. The fact that the escaping gas becomes ignited, is in itself a safeguard, as thus the mingling of unburnt gas with air, which would produce a large volume of an explosive mixture, is prevented.

A particular temperature is needed to initiate the combustion of a mixture of air and combustible gas. Speaking broadly, this temperature of ignition differs with the nature of the gaseous mixture, and is also affected by widely varying conditions. If a combustible mixture of gas and air in a tube is heated slowly from the exterior to a high temperature, a silent or slow combustion occurs, without visible flame and without explosion. If, however, the mixture is rapidly raised to a sufficiently high temperature, a sudden combustion throughout the whole mass of gas, and an explosion, can happen. But it is not every mixture of air and a combustible gas which is explosive. The questions to be considered therefore are: At what temperature does ignition take place? and, In what proportions must the gas and air be mixed in order to detonate?

The temperature of ignition, as already stated, is dependent on different influences. According to Mallard and Le Chatelier, hydrogen ignites at 555° C., carbonic oxide at 655° C., and marsh gas at 650° C. Admixture of indifferent gases raises the temperature of ignition only slightly. On the other hand, many porous bodies—notably platinum sponge—have the power of so accelerating combustion, which is started slowly at a low temperature, that ignition and rapid explosive combustion result. The action of automatic gas lighters depends upon this phenomenon.

With regard to the second question, the proportions in which combustible gases and air must be present in order to constitute an explosive mixture are shown in Table I., and graphically in Diagram I.

TABLE I.—*Results of Explosion Investigations with Mixtures of Gas and Air (in a Tube ¾-Inch in Diameter).*

Description of Gas.	Percentage of the Combustible Gas in the Mixture.		
	No Explosion.	Explosion Range.	No Explosion.
Carbon dioxide	16.4	16.6—74.8	75.1
Hydrogen	9.4	9.5—66.3	66.5
Water gas	12.3	12.5—66.6	66.9
Acetylene	3.2	3.5—52.2	52.4
Coal gas	7.8	8.0—19.0	19.2
Ethylene	4.0	4.2—14.5	14.7
Alcohol	3 9	4.0—13.6	13.7
Marsh gas	6.0	6.2—12.7	12.9
Ether	2.6	2.9— 7.5	7.9
Benzene	2.6	2.7— 6.3	6.7
Pentane	2.3	2.5— 4.8	5.0
Benzoline	2.3	2.5— 4.8	5.0

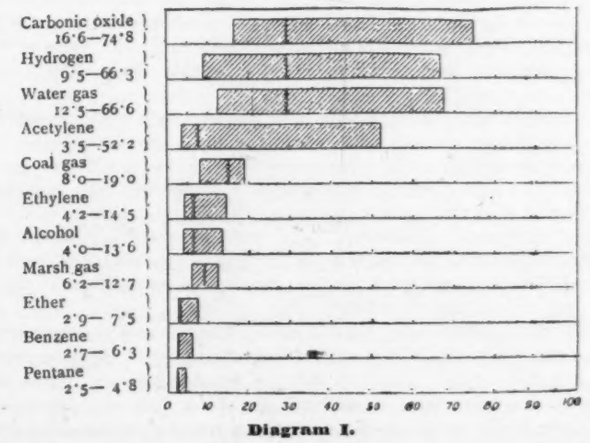

Diagram I.

It is clear that all mixtures of combustible gas and air are not explosive, but only those in which ignition by an electric spark or a flame spreads from one spot throughout the whole mass of gas. This will only occur if the combustion of the quantity of gas first ignited gives rise to

1. *Journal of Gas Lighting.*

such a temperature that the adjacent layers of gas will be thereby ignited, and will in like manner transmit ignition to the whole mass of gas. If there is a great excess of air present, the temperature of combustion, which results at the point of ignition, will remain below the temperature of ignition; and the combustion will not extend. The same thing will occur with the deficiency of air or oxygen—that is, with a great excess of the combustible gas—when the combustion cannot be complete. Thus there are two limits for the proportions of mixture of a combustible gas and air, between which its range of explosion lies. The lower limit is with excess of air and deficiency of combustible gas; the upper limit, with deficiency of air and excess of combustible gas.

These limits differ with the nature of the combustible gas; but they also shift with varying conditions—as, for instance, with the size of the containing vessel, the method of ignition, etc. In order to obtain comparable values for different gases, the experimental conditions must be kept quite uniform, as was the case in the researches here recorded. These have been conducted in a gas burette 19 mm. (¾ inch) wide, and therefore refer to a pipe of that diameter; and ignition of the gas, which stood over water, and was, therefore, saturated with aqueous vapor, was performed by a powerful electric spark. From the above experimental results, the limits of explosion tabulated in Table II. were calculated:

TABLE II.—*Limits of Explosion in a ¾-Inch Tube.*

Description of Gas.	Lower Limit.	Upper Limit.	Explosion Range.
Carbonic oxide	16.50	74.95	58.4
Hydrogen	9.45	66.40	57.4
Water gas	12.40	66.75	54.3
Acetylene	3.35	52.30	49.0
Coal gas	7.90	19.10	11.2
Ethylene	4.10	14.60	10.5
Alcohol	3.95	13.65	9.7
Methane	6 10	12 80	6.7
Ether	2.75	7.70	5.0
Benzene	2 65	6.50	3.9
Pentane	2.40	4.90	2.5
Benzoline	2.40	4.90	2 5

This table includes 12 gases and vapors, of which 2—viz., coal gas and water gas—are mixtures. It shows their behavior in admixture with air.

The several gases are tabulated in order, according to the extent of their range of explosion, which varies greatly with their chemical nature. If the experimental conditions are always precisely similar, the limits of explosion can be established with great precision.

For instance, under certain fixed conditions, a mixture of carbonic oxide and air containing 16.6 per cent. of the carbonic oxide, detonates throughout its whole mass; while one containing 16.4 per cent. does not detonate. Therefore 0.2 per cent. more or less of the combustible gas suffices to convert an incombustible mixture to an explosive one, or *vice versâ*. The range over which the mixture of gas and air is explosive extends with carbonic oxide from 74.95 to 16.5 = 58.45 per cent. of all possible proportions. Hydrogen behaves very similarly; but explosiveness commences with a more dilute mixture (9.45 per cent.) and ends earlier (66.4 per cent.). The explosion range extends over 57 per cent. of all possible mixtures. Water gas is a mixture of carbonic oxide and hydrogen; and its properties lie between theirs. Acetylene concludes the first group of gases, which have a wide explosion range, and therefore form mixtures with air which are specially dangerous.

The second group starts with coal gas, of which the explosion limits naturally vary slightly with variations in its composition—as, for instance, according to the percentages of hydrogen and marsh gas present. Its range of explosion corresponds fairly well with that of ethylene and of alcohol; while the range with marsh gas, which forms the chief component of firedamp, is still more restricted. With the vapors of ether, benzene, and pentane, detonation occurs with less than 3 per cent., but ceases with 7.7 per cent. in the case of ether, and with less in the case of the other bodies.

On seeking the reason for this different behavior of the various gases, we find it is partially due to their chemical nature, but mainly to the amount of oxygen which is required for combustion. Great heat of combustion and ease of ignition extend the limit of explosion downwards; while the great supply of oxygen required by the denser vapors shifts back the upper explosion limit, and restricts the range within which explosion occurs. The quantity of oxygen required for complete combustion differs greatly with the different gases, and is as follows:

Description of Gases.	Volumes of Oxygen Required to Consume One Volume of Gas.
Carbonic oxide, hydrogen or water gas	0.5
Marsh gas	2.0
Acetylene	2.5
Ethylene or alcohol vapor	3.0
Ether	6.0
Benzene	7.5
Pentane or benzoline	8.0
Coal gas	(about) 1.2

Mixtures of combustible gases with the exact quantity of oxygen required for complete combustion are known as "detonating gas." For example: One volume of carbonic oxide with half a volume of oxygen is "carbonic oxide detonating gas." If there is hydrogen in place of the carbonic oxide, the mixture is "hydrogen detonating gas." If the admixture of the combustible gas is with air, the air required is about five times the volume of oxygen; and such mixtures are known as "carbonic oxide air detonating gas," etc. The ratio of combustible gas to air which corresponds to such an atmospheric detonating gas is given in Table III., and is shown on Diagram I., by the space marked by shading inside the area which represents the explosion range. This ratio nearly agrees with the mixture of air and combustible gas with which the explosion exerts the most powerful action, as the smallest quantity of diluents, which do not participate in the combustion, is present, and consequently the highest temperature of combustion is attained.

TABLE III.

Description of Gases.	100 Volumes of Detonating Gas Contain—		100 Volumes of the Exposive Mixture contain Theoretical Detonating Gas—	
	Combustible Gas.	Air.	At the Lower Limit.	At the Upper Limit.
	Vols.	Vols.	Vols.	Vols.
Carbonic oxide	29.6	70.4	24.75	15.78
Hydrogen	29.6	70.4	14.17	21.16
Water gas	29.6	70.4	18.80	20.94
Acetylene	7.7	92.3	11.72	14.03
Coal gas	14.9	85.1	17.40	31.15
Ethylene	6.5	93.5	16.40	23.91
Alcohol	6.5	93.5	15.00	24.17
Marsh Gas	9.5	90.5	18.30	27.47
Ether	3.4	96.6	19.25	22.61
Benzene	2.7	97.3	19.87	22.25
Pentane	2.6	97.4	21.60	22.47

The proportion in which detonating gas is found in the mixture of a combustible gas and air at the lower explosion limit—that is to say, what quantity of gas enters into combustion when explosion occurs at the maximum dilution of the gas—is shown for each gas in Table III. and Diagram II. The shaded part gives the quantities of gas entering into

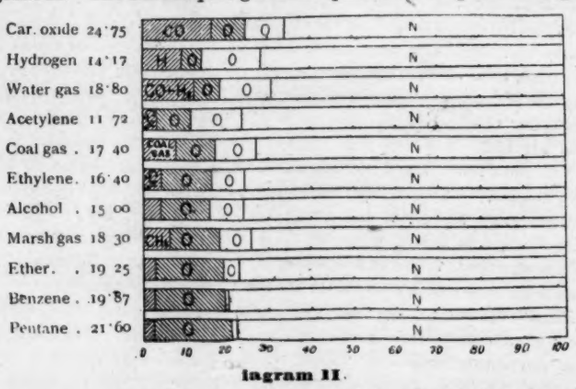

Diagram II.

combustion, the left hand shading showing the combustible gas, and the right hand the air required for its combustion. The adjacent clear space up to the cross line shows the volume of oxygen in excess, and the remaining space corresponds to the amount of atmospheric nitrogen in the mixture. The oxygen in excess and the nitrogen do not participate in the combustion. On comparing the ratios for the several gases, it will be seen that the quantities of "detonating gas" required to initiate an explosion show much smaller differences than were observed in the limits and ranges of explosion. For instance, a mixture of benzene or pentane with air, at the lower explosion limit, contains a greater volume of detonating gas than is present with hydrogen. Acetylene, being an

endothermic gas, of course, forms an exception to these generalizations.

The limits of explosion here given are, as has already been pointed out, only comparative values for the behavior of the gases under like experimental conditions. They are by no means fixed and immoveable, but are modified by very many circumstances—being sometimes shifted, and sometimes extended. The width of the inclosing vessel, the quantity of the gaseous mixture, and the method of ignition all have a very marked influence. For instance, while the explosion limits for hydrogen, in a ¾-inch tube and ignited by an electric spark, are 9.45 and 66.4 per cent.; in a bulb 4¾ inches in diameter and containing about 1 liter, they become extended to 8.7 and 75.5 per cent., or by more than 10 per cent., if ignited in the same manner; while ignition by a gas flame causes explosion when the mixture contains only 8.5 per cent. of hydrogen. Another condition which exercises much influence is whether the mixture is ignited from the bottom of the tube or the top. Under sinilar conditions in other respects, ignition occurs with hydrogen with only 4.5 per cent. of that gas, if it is ignited from below; but 8.5 per cent is necessary when it is ignited from above. Other gases behave similarly.

The pressure and temperature of the mixture also affect the general circumstances under which combustion is started, though, apparently, not to an equal extent with all gases. For instance, Eitner and Bucerius found no alteration of the limits of explosion with the mixture of hydrogen and air with pressures ranging from 0.5 to 4 atmospheres, though the high pressures facilitated explosion, or provoked it in a more dilute mixture, when carbonic oxide took the place of hydrogen. High temperature gives very similar effects. Gradual heating to 570° F. was found by Roscowski to cause only a slight shifting of the explosion limits. Recently, however, Le Chatelier and Boudouard have shown that very much diluted mixtures of carbonic oxide and air can be made to explode by previous rapid heating to a high temperature. While at ordinary temperatures 16 per cent. of carbonic oxide marks the limit of explosibility, 14.2 per cent. suffices at 750° F., 9.3 per cent. at 915° F , and 7.4 per cent. at 1,110° F. for explosion. These observations are of great significance in the application of gases containing carbonic oxide—such as blast furnace gas and producer gas—in gas engines.

The tables given may therefore be used for comparing the behavior of the different gases, which is the object for which they have been drawn up; but it must be clearly understood, in applying them to practical purposes, that many circumstances can cause a considerable extension of the limits of explosion, and that therefore there is danger of the possibility of starting an explosion even when the composition of the mixture differs pretty widely from the conditions specified in the tables.

Further, in laboratory researches, mixtures thoroughly uniform in composition only are dealt with; while the mixtures of combustible gases with air which are found on the practical scale seldom are so. Therefore, there may be at one spot a mixture of a sufficient degree of dilution to avoid explosion, while at another spot all the conditions which make it possible to start an explosion may exist. This is in particular the case when mixtures, such as one of coal gas and air, occur, and no means must be neglected to prevent the occurrence of such mixtures, or to avoid all chance of their ignition.

[To be Continued.]

Electric Gas Lamps and Gas Electrical Resistance Phenomena.

[A paper read before the Am. Inst. Electrical Engineers by Mr. Peter Cooper Hewitt.]

On a former occasion I had the honor of showing to the members of the Institute lamps utilizing the conductivity of gas for illuminating purposes, including experiments illustrating certain laws of conductivity of gases, and I also presented curves directing attention to various characteristics. It gives me pleasure to-night, while showing lamps in operation lighting this room, to describe some of the phenomena exhibited by the lamp and to indicate some of the difficulties encountered in determining the relative value of the resistances therein.

The mercury gas lamps exhibited to-night are operated on the standard Edison 118-volt direct current circuit installed in this building; lamps of this class consume amounts of current varying from 1 to 6 amperes, and the energy is approximately ½ watt per spherical candle power. Under better conditions as high an economy as ¼ watt per spherical candle power has been obtained, determined by careful and accurate measurements. Measurements were made by measuring sections of the lamp varying in length from ¼ of an inch to 3 inches, shielding the lamp and leaving a slot in the shield of the length mentioned and measuring the light transmitted through the slot. These measurements have been made with lamps of various diameters. Dr. Max von Recklinghausen has made independent measurements, comparing the illuminating value of the lamps with incandescent lamps of equivalent rated candle power, and the results of such tests agreed remarkably well with the measurements obtained upon photometers.

I have made lamps with diameter of bore less than ½ of an inch and as large as 3 inches, and from less than 3 inches in length up to over 10 feet giving from less than 10 candles up to fully 3,000. Lamps of very small bores give more trouble in manufacture and operation than those of moderate size. Lamps of innumerable shapes and dimensions have been constructed and great variation of candle power for various diameters obtained. There appears no reason why lamps may not be made of any size required and of any desired candle power per inch within wide limits, the only limitation appearing being that imposed by softening of the glass when too many candle power per inch are produced. The general rules established regarding their operation hold good in so far as examined, and it is possible to predetermine with almost absolute exactness the voltage, current consumption and candle power of a lamp when the manufacture is perfect.

The light produced by pure mercury gas comprises orange-yellow, lemon-yellow, green, blue, blue-violet and violet: and although all shades of these colors may not be present, their absence would not be so seriously felt were it not for the absence of the red. For some purposes the lack of red in the spectrum is objectionable, but for many uses it is a positive advantage.

For shop work, draughting, reading and other work where the eye is called upon for continued strain, the absence of red is an advantage, for I have found light without the red is much less tiring to the eye than with it. It is possible to transform some waves of this light, especially the yellow light, into red light, and thus in a measure to overcome this defect where required for general indoor illumination. A moderate amount of ordinary incandescent light interspersed with the mercury gas electric light serves to supply the deficiency; and the mixture may be made most satisfactory. For ordinary street lighting purposes the mercury light is available even without the red, and it should be noticed that this light has very great penetrating power and seems to be effective through greater distances than an equivalent amount of measured candle power from the ordinary incandescent lamp. This may be due to the fact that the waves of the red light are less penetrating than those waves which are present in the mercury light, and hence the least valuable portion of the spectrum having such illuminating effects is omitted and the energy is practically expended in the more useful portions of the spectrum.

I have made lamps in which this color objection has been overcome, sacrificing on some occasions the extremely high light efficiency obtained in this particular lamp. Without doubt lamps of this type will be produced whose light will be even more beautiful than this light is objectionable; in fact, I have produced very beautiful and becoming light. Every gas gives its own particular spectrum when traversed by current, only part of which is visible, and that one having its spectrum richest in the visible portion is the most efficient for service as a lamp. Each develops its own color peculiarities and presents its particular electrode phenomena, chemical and physical, but I am convinced it is only a matter of patient work to render many gases practically available as light giving media . When it is considered that this light, when obtained with mercury gas, has an efficiency at least eight times as great as that obtained by the ordinary incandescent lamp, it will be appreciated that it has its use in places where lack of the red is not important, for the economy of operation will much more than compensate for the somewhat unnatural color given to illuminated objects.

I would like to state some of the phenomena that had to be unraveled before it was possible to establish the laws governing the operation of electric gas lamps. The conductivity of the gas of the lamp, which is the most important factor, is dependent upon the diameter of the gas column, the length of the gas column, the density of the gas in the column and the resistance factor of the particular gas; with these must be considered the resistance at and about the respective electrodes to obtain the total resistance presented by the lamp. In determining the relative values of these it was assumed that the resistance of the gas column would vary directly as the length; this has so far proved to be true. From the results of a great number of experiments, and from some particular ones, I was able to demonstrate that the resistance varied inversely with the diameter; not as a square, as in metallic conductors, but very nearly as the first power. It is very difficult to obtain identical

surroundings for lamps of different diameters, and I am of the opinion that any discrepancy that occurs is due to difference of environment. I was able to demonstrate that the resistance varies inversely with the quantity of the current passed, which means that the lamp requires a constant voltage unless some change takes place. The voltage across the terminals of the lamp is modified by the density of the gas, a gas having a density of maximum conductivity or a certain definite amount of matter and molecular movement best suited for conduction. Beyond the point of maximum conductivity the resistance appears to increase absolutely direct with the density, but I wish to state that my means of measuring at these low densities were not sufficiently accurate. The density is an entirely controllable factor, and is one of the best means of controlling the voltage. The laws above stated appear to hold good as to gases, generally.

The electrode resistance at the positive, providing there is no alteration of the chemical or physical condition of the electrodes, may, from a practical standpoint, be regarded as being very slight and will be neglected for the present.

The negative electrode resistance offered very great difficulties and required long and patient experimental investigation. I found that it consisted of a variety of factors, and I will briefly direct attention to those which appear to have the more important bearing upon the operation of the lamp. There is a reluctance to the initial passage of current which appears as if self created by the current—as if by induction. Upon increasing the voltage applied thereto, current passes to a very small extent and thereupon there is a fall in resistance. To increase this small amount of current the voltage must be still further increased. On further increase of current this resistance apparently ceases and there is an enormous decrease of voltage. This resistance apparently does not exist when chemical or physical alteration occurs at the electrodes.

When the last named resistance is overcome by reason of passing current, a flame may be noticed proceeding from the negative electrode in a direction perpendicular to the surface from which it issues. If this flame meets the current in a right line, that is to say, projects in the direction of the flow of the current at the point of meeting, the total resistance of the lamp is materially greater than when the flame proceeds in a direction at an angle to the flow of the current.

When the flame is proceeding from the negative electrode at an angle to the line of the current, then the resistance at the negative electrode, under the conditions which are established, is reduced, and practically speaking, the principal and controlling resistance of the lamp is then located in the gas path proper.

The reluctance to starting is greatly modified by charging the surface of the lamp exterior to the negative electrode positively, and also in a less degree by dissipating the charge that collects there. It is for this reason that the lamps have a conducting band exterior to the negative. This resistance may also be modified by charging and discharging the lamp with a high voltage current.

I may here add that these initial resistances to the passage of current may be overcome by an impulse of high potential, as by the discharge of a reactive coil.

Electrical relations, as well as chemical, exist between the various kinds of gases used and electrodes of different materials, so that the presence of some other matter, "foreign matter," may bring about a total change of conditions and phenomena which normally should exist at the negative electrode in a state of purity. These conditions give rise to new and unexpected phenomena, and phenomena of great importance are brought into existence at the positive electrode. In the practical manufacture of the lamp, when abnormal conditions arise, that is to say, when other phenomena than those above outlined appear, or those above outlined do not appear, it is customary to attribute them to the presence of "foreign matter."

From what has been stated, it will be seen that the problems which had to be solved to produce a lamp, comprised, among others, not only the determination of the conductivity of the gas column, involving the relations of the length and diameter, but determining the relative values of the other different factors of the electrical resistances, resistance at the electrode, etc.; determining the conditions accompanying varying densities, the variations in the conductivity with respect to the amount of current flowing; also methods of finding a pure gas with stable chemical and physical conditions within the lamps, and also determining the relations of the electrodes and gas with respect to each other under operating conditions.

In one experiment shown upon the former occasion referred to, the initial resistance to the passage of the current was illustrated and the electrical leak through this resistance was measured; but at that time no attempt was made to point out the several resistances or factors thereof which have been referred to above.

In some particular forms of lamp the resistance at the negative electrodes has been availed of to render the negative electrode itself a source of light. Such conditions were established that no physical or chemical change took place at the negative electrode, and it developed that the electrode could then be heated to any desired temperature. Iron electrodes under these condiiions may be maintained at a very high temperature and give off considerable light, the electrode itself being then the chief source of light. I even succeeded in melting platinum and maintained it in a molten puddle.

I might mention an interesting negative electrode experiment where an ordinary lamp about 30 inches in length contained a rod of metal one-eighth inch in diameter, projecting from the mercury negative to an eighth of an inch of the positive electrode, which was located as usual, and a movable bridging piece permitted bringing this rod into electrical connection with the positive. On forming contact and breaking, the current shoots to the mercury negative, although the total resistance over the lamp requires 60 volts with about two amperes passing, while that of the rod was negligible with respect to ohms.

The presence of slight impurities in the lamp serves to vary the resistance to starting in a very marked degree. Under some conditions impurities or "foreign matter" facilitate conduction, whereas under other conditions "foreign matter" serves to greatly increase the resistance.

Referring again to the flame occurring at the negative which is present while the lamp is in operation, it may be stated that the direction of the flame is largely, if not entirely, independent of the direction of the current, and is determined by the plane of the surface receiving the current. The direction of the flow of the current to that surface is, generally speaking, through the shortest path from the positive electrode, so that if the entrance plane of the negative electrode surface be out of the perpendicular to the flow of the current, then the flame may be made to proceed in a direction out of the path of the current, and thus will not interpose its resistance to the current flow. In some of the types of lamps shown here to-night, the surface of the mercury constituting the negative electrode, as will be seen, does occupy such a position with relation to the path of the current, and the flame proceeds in a line out of the path of the current. In some of the lamps, for the purpose of causing the position at which the current passes into the negative electrode to remain fixed and the flame regulated, the metal leading-in-wire is carried to a point at the surface of the mercury, and the path of the current once being fixed upon this point, remains there instead of wandering about the surface of the mercury, the current entering the meniscus.

The flame may be deflected and its position controlled by the use of a magnet when so desired. Where no point is used there is a tendency for the current to wander and burrow, as it were, into the body of mercury. This results in temporary depressions, so that the flame may proceed from the walls of these depressions in a direction at an angle to the direction taken by the current, but the wandering of the current about the surface of the mereury will necessarily cause a constant shifting of the direction of the flame and cause variation in the resistance of the lamp.

I have used other gases than the vapor of mercury as the gas path, but mercury is more convenient for general experimental investigation for many reasons, among them the fact that as a negative electrode, its resistance is stable; the readiness with which the alteration of its condition may be brought about; the high efficiency of a mercury gas as a light giving medium, and also the fact that it can easily be obtained in a fairly pure state.

Technical Education.

Engineering (London) remarks that whilst a great deal has been accomplished during the past few years in this country in the matter of providing facilities for the scientific training of those to be engaged in the direction of our great manufacturing industries, much still remains to be done before our technical institutions can compare in magnitude or equipment with those of America and Germany. Whilst on the whole ample facilities are now provided for elementary scientific training, the average Englishman is still unable to appreciate the necessity of more advanced work, so that whilst money can readily be raised to equip almost any number of second rate polytechnics, comparatively little is forthcoming towards the support of the institutions in which really advanced work is being carried on. A curious illustration of this habit of mind is to be found in the fact that whilst no nation can show a more numerous selection of elementary treatises on chemistry, the great work of Roscoe and Schorlemmer is no longer published here,

whilst a new edition has but recently been issued of the German translation. Our American friends used to be credited with a reputation for acquiring a mere smattering of the sciences, and for thinking this all sufficient, but this reproach has long ceased to be applicable, and the numerous establishments in which advanced work is done in the United States are exceptionally well endowed and well equipped. Again, whilst in England the average length of the course at a technical school is 3 years, in America it is 4, and the students can hardly enter the school less well grounded than does the average public schoolboy here. In fact, most of our colleges have an extremely low standard for their entrance examinations, though there are one or two exceptions to this general rule. Experience seems to show that whilst a 3 years' course suffices to give an intelligent youth a fair grasp of principles, it affords him little opportunity of carrying out research work on his own initative, which would give him a most valuable training in compelling him to think for himself. We know that the professors of some of the principal schools have been anxious to have a fourth year's post graduate course of this character, and to a certain extent have been able to carry out their wishes; but such a course, though not "post graduate," forms a portion of the regular curriculum at many American schools. Not unfrequently the graduating theses in these schools have in this way made contributions of permanent value to engineering data.

In spite of the fact that a 4 years' course is usual abroad, the age at which students are admitted is generally higher than in this country, being 18 in place of 15 or 16, as here. Even so, the number of such students is considerably greater than here. In England, taking the figures given in the report of the Association of Technical Institutions, there were in 1900 345 third-year and 52 fourth-year engineering students at the technical schools of the United Kingdom, and of these some had entered at the age of 15. In the Charlottenburg Technical High School alone there were in 1900 235 third-year and 242 fourth-year students in engineering, whilst about 300 students leave annually the Massachusetts Institute of Technology after completing a 4 years' course.

Whilst the output from English schools is so low, as compared with that of our principal competitors, it is to be feared that is still, if anything, rather in excess of the demand. In the case of the Massachusetts Institute of Technology, the number of applications from manufacturers for graduates is so great that everyone is provided with an engagement before he completes his course. In this country most of the students find some difficulty in getting a situation at all, and even then get either no pay whatever, or none to speak of, for a considerable period. This is not because they are found useless, since in more than one case within our knowledge these youngsters, whose services were gratuitous, were almost immediately put on to work previously done by some of the best paid labor in the shops. Quite recently a large firm would consent only to take a youth of this kind as an ordinary four-year apprentice, so that had their proposal been accepted he would, at the age of 21, start at a wage of 5s. per week, and at the age of 25 would have been earning the munificent sum of half-a-guinea. In America, as already stated, the work shop managers have a higher appreciation of the advantages of a good grounding in scientific principles and of the acquirement of a habit of accurate observation. They engage technical graduates readily, and find them useful in most unexpected directions. In our last issue (page 870) we described how the Bethlehem Steel Company had employed a corps of such students to conduct the investigations by which they have succeeded in reducing their staff of laborers to one-quarter its original size. It is simply impossible to conceive of a British firm dealing with a question of this kind in this way. If there was a suspicion that the laborers were too numerous for the work done, the management might possibly give a draughtsman a fortnight to look into the matter, in conjunction with a foreman, but they would never agree to keep a special staff at work for many months in a thorough investigation of the whole question, as the Bethelehem Company did. Indeed, even in the States the scheme of employing a number of inexperienced youths in such a matter excited no little ridicule when first broached, but the result has shown the acumen of the management.

In addition to having but a short course of study, our English technical schools suffer largely from the imperfect education of the raw material entering them. As already indicated, the entrance standard has in most cases to be fixed at a low level in view of the deficient nature of the instruction provided in the larger public schools, and in the private schools modelled thereon. A reform in this regard will doubtless ultimately be effected, as the matter is attracting serious attention in at least one of the great universities, where it is asserted that it is most exceptional for a public school man to make his mark, whilst in order to get their pupils into the army without the assistance of a crammer, the heads of the public schools agitated a short time back for a reduction of the standard. Whether their wishes in this respect were acceded to we do not remember, but we are credibly informed that 60 per cent. of the candidates at the last examination spelt "cannon" as if the word had reference to an ecclesiastical official. Unfortunately, the system of education which leads to such results is warmly supported in the public press, which at the same time is largely governed by the delusion that it is the workmen in an establishment, and not the managers, who are in need of technical instruction. Any reform proposed in the present system of secondary education is met by a cry that what is needed is culture. The latter quality is difficult to define; but if we may take Emerson as a guide, it consists in an ability to write and talk gracefully and intelligently on a wide range of subjects.

Up till recent years, the practical applications of science were so few that, perhaps, there was but little necessity that the man of culture should have some understanding of engineering matters, but at present mechanism enters into every department of our daily life, and no one can avoid having to touch upon it in conversation or in writing. It is here that the old system shows its weak points. The leader writers of our great daily papers are largely recruited from Oxford, which, indeed, though singularly destitute of great names in either literature or science, furnishes the bulk of the second class literary men who edit the daily papers and monthly reviews. These write on all subjects, and generally well; but when their evil stars compel them to discourse on scientific or technical matters, their ignorance of the most common elementary facts is little less than astounding. Unfortunately, these gentlemen have in the nature of things a great influence over public opinion, and it is doubtless largely due to them that we see the present waste of funds in the establishment and support of second rate polytechnics, whilst the higher class institutions are most inadequately endowed. Thus the National Physical Laboratory gets out of the Imperial Treasury the absurdly small sum of $20,000 per annum; whilst the "beer money" appropriated to technical schools of the second and third rank amounts yearly to nearly $5,000,000. It is, however, possible that the expenditure of this vast sum in this way is a necessary preliminary to teaching the public the supreme importance of work of higher quality. The man who has some elementary knowledge of scientific matters will spot the absurdities which now too frequently fall from the pens of the average leader writer, and a demand will ultimately arise for gentlemen of a wider culture, and less restricted education, to direct the energies of the Press. Till this time arrives our leading technical schools must, we fear, continue to compare badly, both in equipment and in the dimensions of their teaching staffs, with similar establishments abroad.

The Functions of Arresters and Choke Coils.

In a circular (No. 1,045) on these matters recently issued by the Westinghouse Company it is said that electrical apparatus may receive injuries of two sorts from lightning, namely, grounds and short circuits. Grounds are caused by an abnormal rise of potential of the insulated portions of the apparatus above that of the earth. But as any properly designed piece of apparatus has sufficient insulation strength to withstand a potential considerably higher than that normally impressed upon it, a lightning discharge must cause a very considerable rise in the potential of the circuit to produce a ground. Short circuits are caused by the suddenness of the static disturbances produced by lightning. On account of this suddenness, the static wave in the line, which is the form of disturbance produced by the lightning discharge, strikes the coil a blow, so to speak, which under favorable circumstances will cause a short circuit. In general, electric apparatus evidently requires lightning protection of two sorts. First, protection against grounds; second, against short circuits. Protection from grounds is secured by means of lightning arresters. Protection against short circuits, by choke coils.

The proper function of a lightning arrester is to prevent an abnormal rise of potential, above the earth, in an insulated circuit. This result is best attained by placing one or more carefully adjusted air gaps between the insulated circuit, commonly called "line," and an earth connection or "ground." Except during times of discharge these gaps resist all flow of current from the normal voltage of the line, but whenever the line potential rises abnormally they break down and allow a free discharge of electricity. By careful adjustment of the gaps, an arrester can be made to discharge when the voltage of the line has risen to any predetermined value. On account of the extreme sud-

denness of the surges caused in the line by lightning discharges, the gaps and ground connection must be able to discharge very freely, or a rise of potential of the line will not be prevented; that is, the lightning arrester as a whole must be able to discharge electricity faster than the charge can come from the line.

It is found that there is a very strong tendency, especially with generators of large output and high voltage, for an arc to form in the gaps when once their resistance is broken down by lightning discharge. This arc, which can only occur when one line is grounded, or when two lines from the same generator discharge at once, is maintained by the generator, and if not prevented or extinguished will cause a shut-down of the plant. Consequently the lightning arrester, in addition to preventing an abnormal rise of line potential, must also suppress any arc which tends to form in the arrester gaps. The latest and best types of light ning arresters used on high voltage alternating-current circuits render the arrester non-arching under all conditions. As the two functions of a lightning arrester, namely, the prevention of a rise of potential on the line and the suppression of any arc forming in the gaps, are more or less antagonistic, practically all previous types of lightning arresters performed one of these functions better than the other. The "low equivalent" arrester, however, performs both of these functions in a most complete manner, and, therefore, it represents an advance over all other types.

The principal function of a choke coil is to prevent the short circuits sometimes caused by the local concentration of potential which is commonly produced by a lightning discharge. The choke coil serves also, to some extent, in limiting any abnormal rise of potential in the apparatus by delaying the advance of the discharge from the line and allowing more time for the arrester to act. As already stated, the discharge caused by a lightning flash passes along the line in the form of a surge or "tidal wave." If this wave passes a choke coil it is flattened out and, if the coil be of sufficient power, becomes practically harmless. It is evident, however, that the choke coil receives the full force of the wave and, consequently, must be heavily insulated. Moreover, choke coils must not overheat under load, nor introduce an excessive inductive resistance into the circuit.

It is evident, then, that the requirements for choke coils, as stated above, are more or less conflicting, as for example, large choking power means many turns and much heat generated, nevertheless the best choke coils are so proportioned that the greatest possible protective effect is secured without undue heating or cost of copper.

Stoppages Caused by Naphthaline.

The *Journal of Gas Lighting* reports that at the Winter Session of the Institution of Gas and Water Engineers of the Mark Brandenberg (Germany), an interesting discussion took place on the subject of the removal of stoppages caused by naphthaline.

Herr Sartorius (Aschersleben) said that, for several years back he had experienced much trouble from stoppages caused by naphthaline in the works plant. A speech on the subject by Dr. Bueb had, however, attracted his attention; and he communicated with that gentleman. According to his (Dr. Bueb's) advice, he provided himself with a "Standard" washer; filled it with anthracene oil; and since that time naphthaline stoppages had completely ceased, so that he was now perfectly free from it, while formerly he had much naphthaline deposited, especially in the inlet and outlet of the gasholder. A large proportion of the naphthaline, however, remained in the earlier portions of the plant, and in the tar tanks; so that he had to clean them every fort night, and often took out two cement casks full of dirt, which had gathered there To gain more advantage from the anthracene oil used, Dr. Bueb advised him to employ it for making the tar thin in the tar tanks. He had followed this advice. But about a fortnight ago he had discovered that the tar in the tanks had become thicker instead of thinner, so that he had to warm the tanks in order to loosen the material from the bottom. After putting out of work the bench to which this tank belonged, the substance on the bottom became as hard as asphalt. He had had the same experience with the tar wells, where the anthracene oil which had been used had produced the same effect. He could not immediately sell the tar, and therefore he was compelled to leave the tank untouched; the result being that the tar subsequently became so thick that the pumps would not work. Since then, he had run the anthracene oil containing naphthaline directly into the tar, and did not let it go first into the wells. The quantity which had to be used for a production of 35,300,000 cubic feet of gas was not very large; but, according to his practical experience, he had decided not to use it any more for thinning the tar in the tanks. He did not know whether anybody else had tried the same treatment. The "Standard" washer had proved very successful, but the attempt to make the tar thin by the use of oil had failed.

Herr Rother (Spandau) remarked that when naphthaline obstructions occurred in the works, they could be removed by steam. During the last winter, he had had much trouble with naphthaline in his works; but he was pleased to say there had been less of it this year, for the following reason: He had had short ascension pipes, and consequently the hydraulic main was placed low. Last year, however, a new retort bench was built, with the ascension pipes 6 feet longer, and, of course, the hydraulic main was so much higher. Since this bench had been in use, he had never experienced any inconveniences from naphthaline stoppages in the works, but had had more trouble with them in the town mains. One night, about seven o'clock, he was informed by telephone that in one part of the town the pressure was very low. Being Saturday night, and after closing hours, it was impossible for him to make a thorough investigation, and the result was that the trouble continued on the following day, and even on Monday night the pressure was not sufficient. He then found, however, by testing the pressure from lamp to lamp, that naphthaline had collected at a point where the main left the warmer temperature of the ground and passed under the bridge across the River Havel—that was to say, in the zone of frost—and there it had become obstructed by naphthaline throughout its entire length. He at once thought of Dr. Bunte's suggestion to remove naphthaline by means of crude xylol. Fortunately, he had provided himself with a bottle of it, and consequently he was able to apply it at once. The question to be settled was in what condition the crude xylol must be used, and in what way a practical gas manager could ascertain whether or not it was of the proper quality. As prices varied so greatly—differing to the extent of about $50 per ton—he came to the conclusion that there must be several qualities of xylol; and if this was so, the meeting would be glad to know how they could ascertain the right one. It was well known that vaporized xylol would precipitate again by condensation and could be recovered; and thus the fact led him to consider whether it could not be used again with equally good results. This was the question he wished to have discussed. He had on several occasions had obstructions in the same place, and could not get the naphthaline out by mechanical means, but by the application of vaporized crude xylol, an improvement was immediately effected. A blowpipe was of little use in the case of hard frost, but he had often obtained good results by the aid of a charcoal fire.

Dr. Bunte (Carlsruhe) said xylol had great solvent power for naphthaline, and in this respect was superior to several similar fluids which had been employed. Moreover, it must be borne in mind that it had the peculiarity of precipitating almost entirely, if the temperature went down to about 10° C. (50° F.). The crude xylol should not contain any easily vaporizing constituents such as hydrocarbons, otherwise (as Herr Rother had correctly stated) that which was to be blown in as vapor in a warm condition would not again precipitate in the next or one of the next drip boxes. If a liquid containing large quantities of hydrocarbons of low boiling point was employed, these remained for the most part dissolved, and the gas would become, so to speak, carburetted, and consequently the gas which reached the consumers would be richer in benzol than that generally sent out from gas works. As this fact had not been taken into consideration in arranging the air inlets of the Auer burner, the mantles were rendered smoky. A so-called "anti-naphthaline" which had been put upon the market, and which contained a good deal of benzol, possessed this quality. It certainly dissolved naphthaline, but it partially precipitated again, and might interfere seriously with the efficient burning of the gas. This bore upon the question of the quality of the crude xylol. It should contain but little benzol, and not boil below 125° C. (257° F.).

The high boiling point did not militate against the employment of crude xylol in the form of vapor. The small boiler, fitted with a tube, or something similar, by which vaporized benzol could be blown through a hole into the gas main, might be utilized with xylol for removing the naphthaline from a dangerous part. The vaporized xylol was blown towards the naphthaline, or it flowed with the stream of gas, and dissolved the naphthalene, and in a very short time removed the obstruction. The boiling point of the crude xylol should not, however, be too high—say, from 125° to 180° C. (257° to 356° F.). It was very difficult to manufacture pure xylol; it was really a mixture of different isomeric hydrocarbons, principally metaxylol. But for the purpose in question, it was not necessary to use pure xylol, which was very dear; the price being regulated by the quality. The crude xylol he had been referring to was known as commercial benzol IV., V., and VI. Their

specific gravities at 15° C. were .875, .878, and .900; and at the following temperatures the percentages shown were distilled off:

Temperatures of Distillation.	IV. Per Cent.	V. Per Cent.	VI. Per Cent.
125°	12	—	—
130°	37	*nil.*	—
135°	61	2	—
170°	81	27	—
175°	90	57	*nil.*
150°	—	76	8
155°	—	86	33
160°	—	90	55
165°	—	—	71
170°	—	—	83
175°	—	—	90

He would be pleased to go into this question; and if Herr Rother would send him some samples of his crude xylol—say about 1 pound—he would be able to ascertain its qualities. He wished to make it clearly understood that crude xylol was a relatively cheap hydrocarbon, even if at the present time it was dearer than benzol. Quantities of it could be obtained in the distillation of tar. He might add that crude xylol was specially applicable for the removal of naphthaline in the cases instanced by Herr Rother, where the immediate removal of obstructions at certain points in the canalization, such as where the gas was suddenly cooled in a main which left the ground and was carried above a bridge.

Herr Rother asked if the xylol which had been used and afterwards recovered was of no value, or could it be employed over again.

Dr. Bunte said tne xylol contained some naphthaline in solution, but was frequently not saturated with it, and therefore it might be used repeatedly. This could not be done for any length of time, for in addition to the naphthaline, hard tar deposits on the mains were taken up. But the xylol could be recovered by distillation, and possibly the material could be sent to the tar distillery and exchanged for fresh xylol. The commercial benzols he had alluded to had about the following composition:

	IV. Per Cent.	V. Per Cent.	VI. Per Cent.
Toluol	25	5	—
Xylol	70	70	35
Cumol	5	25	60
Neutral naphthaline oil	—	—	5

With regard to the thickening of tar in the hydraulic main, he would just remark that anthracene oil should not be put into the main, as many of its constituents had high boiling points, which might easily cause thickening. Consequently, it was not possible to remove naphthaline from the hydraulic main in this manner. But there was another way of removing thickened tar—the one employed in tar distilleries. If tar oils having a higher boiling point than xylol were pumped through the hydraulic main, the thickened tar would be dissolved. Xylol might also be used without hesitation to remove stoppages in hydraulic mains. He recommended a trial of it.

Herr Sartorius remarked that when he stated that he had had naphthaline obstructions in the works, he should have added that he had also had stoppages in the town mains. This trouble had now become less—or rather, he should say, it had been entirely removed—by separating the two chambers of the washer, and by treating them with anthracene oil. He had drilled holes in several parts of the pipes to ascertain if they were free from naphthaline, and had found that this had been so. The obstructions at the public lamps, which, as was well known, occurred very easily, had also disappeared. With regard to the simple way of removing naphthaline obstructions mentioned by Herr Rother, he (Herr Sartorius) was compelled to consider some means of doing this when these troubles occurred suddenly, and he had to devise something that would be of practical use. He accordingly fixed upon a place between two lamps (he knew the stoppage would occur within 55 yards); drilled a hole in the main, which had been stopped off, inserted the xylol, and then evaporated it by means of soldering lamps. Primitive as the arrangement was, it proved successful. Herr Rother had questioned him as to how he had removed the obstructions, and he told him. Herr Rother had adopted the same method, with the only difference that he had employed coke fires.

Herr Baumgaertel (Luebben) said the main from his works crossed four bridges, and he had to deal with naphthaline obstructions, especially in cold winters, and had done so satisfactorily. From time to time he had poured hot alcohol into the main, through the public lamps, just before it reached the bridge; and since then he had had no further trouble with stoppages. As far as the removal of naphthaline from the gasholder connections was concerned, he did this by simply passing gas liquor through them.

Dr. Bunte subsequently made an analysis of the crude xylol and "anti-naphthaline" employed by Herr Rother, with the following results: The sample of the former was clear and of a yellowish color, had an aromatic odor, and a specific gravity of .874 at 17° C. (30° F.); that of the latter, water clear, with a strong smell of isonitril, and of .837 specific gravity—its bromime saturation point being 59.5 per cent. The figures of the following table show the percentage yield by volume of the two materials on distillation:

Crude Xylol.

Temperature of Distillation.	Per Cent.
80° to 90° C.	14
90 " 100	39
100 " 110	50
110 " 120	53
120 " 130	57
130 " 140	60
140 " 150	64
150 " 160	75
160 " 170	93

Anti-Naphthaline.

Temperature of Distillation.	Per Cent.
52° to 60° C.	4
60 " 70	8
70 " 80	18
80 " 90	45
90 " 100	74
100 " 110	89
110 " 120	93

The Photographophone or Electric Arc Kinematograph.

Engineering says that the speaking arcs of Simon and of Duddell have induced Ernst Ruhmer, of Berlin, to turn the kinematograph on the electric arc. The arrangement is described in the *Annalen der Physik*, 1901, vol. v., page 803. The arc is produced between two horizontal homogeneous carbons on a 220-volt circuit with resistance in series. The arc circuit further comprises an induction coil of 900 turns of 2-millimeter copper wire, surrounding an iron core, and a microphone or a liquid interrupter in a shunt; thus intermittent currents are superposed upon the continuous currents. In front of the arc is a slit, 1 or 2 millimeters in width, formed by pieces of sheet metal; further off is the kinematograph. The slit produces an image of the two carbons on the ground glass. When the kinematograph is in motion, the arc appears as a bright continuous band, the bright border on the one side marking the positive crater. When the arc hisses, the band becomes wavy, but the positive boundary keeps straight. The liquid interrupter cuts the band into rectangles of varying lengths; *i. e.*, the rectangles are first increasing, and then decreasing in length, while the dark space between the rectangles (the periods of interruption) do not appear to vary in length. When the arc is blown out by an electromagnet, the arc images seem spontaneously to relight again without becoming altogether extinct, as long as the noise resembles whistling; when the arcs make a rattling noise, they show distinctly separated drawn out flames.

When the experimenter whistled into the microphone, some 1,500 vibrations could be counted on the band of the arc image. Ruhmer finally talked into the arc, the apparatus being so arranged that a lens produced an image of the steady arc in the shape of a very fine bright line running right across the film, which was travelling at the rate of 3 meters per second. To reproduce the impression thus obtained, Ruhmer uses the same box camera, with its two pulleys, the upper one of which is rotated by an electric motor, But the arc now serves as the projector lamp, and the film travels with the same speed as during the exposition, in front of a selenium cell of high sensitiveness. The variations in the light intensity of the photo-phonogram are then converted into variations in the resistance of the selenium cell and of the current intensities in its circuit; and speech, the author states, is reproduced in two telephones coupled in series, with surprising distinctness. The tones are louder than in the Poulsen telegraphone, which we described last year, and the character of the voice is well preserved, we read in Ruhmer's paper. This is certainly astonishing, though we ought to know by this time that almost everything can be made to speak electrically.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

A CORRESPONDENT informs us that the properties of the Lacconia (N. H.) Gas and Electric Light Company, capitalized in $25,000 and bonded in $40,000, have been purchased by a syndicate of Keene (N.H.) capitalists, who took possession of the works last Wednesday. The Company has been operating an oil gas plant of the Kendall type, and the new owners propose to put that out of commission and rebuild the plant on modern lines. The Keene syndicate is practically the one that recently purchased the works and rights of the Leominster (Mass.) Gas Company, and another of its properties is the Keene Gas and Electric Light Company.

THE Western Gas Construction Company has contracted to supply the Michigan Alkali Company, of Wyandotte, Mich., with an improved P. & A. tar extractor of a per diem capacity of 2,000,000 cubic feet. The Western Company will also install for the Alkali concern a Holmes "New" washer, for which the firm is the American agent.

IT is a certainty that the gas plant proposed for Seattle, Wash., by the Citizens Light and Power Company, will be built. The leading parties in interest are Messrs. J. W. Clise, of Seattle, and Lyman C. Smith, of Syracuse, N. Y. The plant which is to be constructed on coal and water gas lines, will be erected under the supervision of Mr. C. R. Collins. The plans call for a works up to a daily output of 1,000,000 cubic feet.

AT the annual meeting of the Paris (Ky.) Gas Light Company, which came under the control of Mr. J. W. R. Cline and his friends some months ago, the following officers were elected: Directors, J. W. R. Cline, W. R. Wones, Jno. T. Hinton, Claude M. Thomas and Benj. Perry; President, J. W. R. Cline; Secretary, Claude M. Thomas; Treasurer, J. W. R. Cline. The reforms instituted by Mr. Cline are bearing good fruit, and he proposes, with the aid of Mr. Wones, to do a smart bit of construction work on the manufacturing and distributing plants the coming spring.

GOVERNOR CRANE, of Massachusetts, in his annual message to the Legislature of that State, recommends that the administration of the affairs of the State Inspector of gas and gas meters be placed under control of the Board of Gas and Electric Light Commissioners From our point of view it would seem that the plan of operation as at present carried out is superior to the one proposed by the Governor.

MR. A. H. CAMPBELL has applied to the proper authority for the appointment of a liquidator to wind up the affairs of the Brampton (Ont.) Gas Company.

AT the annual meeting of the shareholders in the Cranford (N. J.) Gas Light Company the following Directors were elected: John Kean, J. H. Kean, F. Engel, F. A. Price and H. B. Motell.

"R.," writing to the JOURNAL some days ago, from Norfolk, Va., says that the City Gas Company, of Norfolk, Va., enjoyed a very prosperous year, as may be readily understood from this concise presentation of facts. A dividend for the year of 3 per cent. has been declared, as against a 2 per cent. return for 1900. The sales of gas show an increase of 14½ per cent. for the twelvemonth as against a 12.7 per cent. increase in 1900 over 1899. On January 1st the Company began to pump gas through its new purifying house, which is fitted with an 8-foot scrubber and 2 boxes, 16 feet by 20 feet; the divided flow plan is followed, and the valve system is of the double-seating type. The estimated capacity of the house is 1,200,000 cubic feet per day. The working of the house has so far been very satisfactory. The installation was made by Messrs. Bartlett, Hayward & Company. The new house is to be used for water gas purification only, the old house being employed on the coal gas make. During the past year the coal gas plant was enlarged, and all necessary changes made for handling and metering the coal gas separately. A Rowland ammonia concentrating plant was installed, and material additions and improvements were made to the boiler plant. The Company has completely remodelled the interior of its office building, adding greatly to its convenience, and especially enlarging the floor space for display and sale of appliances. The sales' department receipts have increased about 100 per cent. in the past year.

ANOTHER deal has been made in the properties of the Orange County Gas and Electric Light Company, which operates in Middletown and other contiguous places in Orange county, N. Y., whereby Andrew L. Fennessy, Philip N. Jackson, E. R. Case and their allies came into possession. The new Directors are: A. L. Fennessy, Philip N. Jackson, T. L. Reeve, L. C. Purdy, H. C. Hittorf, W. E. R. Smith, E. R. Case, C. J. Shearn, W. H. Fritchman and Cornelius Fitzgerald; President, Andrew L. Fennessy; Vice-President, Philip N. Jackson; Treasurer, Cornelins Fitzgerald; Secretary, W. H. Fritchman. Mr. William J. Max continues as Superintendent.

THE proprietors of the Nashville (Tenn.) Gas Light Company have turned into the city treasury $4,697.63, which sum represents 5 per cent. on the Company's gross earnings for the 6 months ended December 31, 1901. The payment on like account for the 6 months ended June 30, 1901, amounted to $5,204.52; a total for the year of $9,802.15.

A CERTIFICATE announcing the incorporation of the Municipal Gas and Electric Company, of Rochester, N. Y., has been filed by Messrs. Anson R. Flower, C. K. G. Billings and H. C. Brewster. The capital stock of the concern is put at $2,500,000, and the corporate existence is for 50 years. The operations of the corporation will not be confined to Rochester, but will cover the complete territory of Monroe county. It is understood that the selling rate is to be put at $1 per 1,000, and that the gas supplied will be of 24-candle power. The price charged by the Rochester Company is $1.40 per 1,000, less 15 cents per 1,000 for prompt payment.

UNDER an ordinance recently adopted by the authorities of Bakersfield, Cal., each gas and electric company doing business in that city must pay a license tax of $20 per quarter.

PRESIDENT LAWRENCE, of the Suburban Light Company, of San Leandro, Cal., has notified the residents that, until further notice, the selling rate for gas will be $2 per 1,000.

AT the annual meeting of the Lebanon (Pa.) Gas Company a semi-annual dividend of 4 per cent. was declared and the following officers were elected: Managers, Rudolph Behm, H. C. Grittinger, J. P. S. Gobin, Chas. H. Killinger, John W. Mish, L. E. Weimer and W. W. Mish—the latter succeeds the late Anthony Aurentz; President, L. E. Weimer; Vice-President, H. C. Grittinger; Secretary and Treasurer, John W. Mish—this is Major Mish's 47th consecutive election to the offices which he has so capably and conscientiously filled.

MR. W. A. LEARNED, the wideawake and successful Manager of the Newton and Watertown (Mass.) Gas Light Company, is not a whit less accessible than ever, even though the business offices of his sterling corporation have been removed to commodious quarters in the building formerly occupied by the Newton National Bank. The showrooms and sales' quarters are especially attractive—in fact the building has been virtually reconstructed as to its interior arrangement, and the President of the New England Association of Gas Engineers will, of course, be more than pleased to have gas men who "come his way," inspect the beauty, utility and scope of the Company's at home quarters.

THE Common Council of Holland, Mich., has ordered that the matter of constructing a gas plant in that place be submitted to the voters at the spring election. The vote is to be had on a double proposition: First, as to whether or not the city should bond itself in the sum of $75,000, the money to be expended in the construction of a plant for operation on municipal account; second, whether or not a franchise for the purpose outlined should be granted to private capitalists.

AT the annual meeting of the Danville (Ky.) Gas Company the following Directors were elected: C. H. Rodes, J. A. Heron, J. W. Yerkes, W. B. Thomas, J. A. Quisenberry, J. B. Fisher and J. A. Cheek.

APPLICATION has been made to the authorities of Collinwood, O., by the proprietors of the Cuyahoga Gas Light Company, for the right to there operate a gas works. The applicants offer to sell gas at the rate of 70 cents per 1,000 cubic feet, and to pay into the Collinwood treasury 6½ per cent. per annum of the gross receipts. Collinwood is situated in East Cleveland township, Cuyahoga county, at a point 7 miles east of Cleveland. It is on the Lake Shore Railroad, is notable for its clay goods manufactures, and has a population not in excess of 3,500.

THE business offices of the Youngstown (O.) Gas and Consolidated Light Company have been removed to the Park theater building, on South Champion street.

THAT considerable interest was manifested in the annual meeting of the Nashville (Tenn.) Gas Light Company is shown in the fact that $950,000 out of the total capitalization of $1,000,000 shared in the voting. The Directors elected were: T. H. Malone, A. H. Robinson, W. R. Cole, T. J. O'Keefe, J. H. Fall, Joseph H. Thompson, B. F. Wilson, J. B. Richardson and D. S. Williams.

THE Pontiac (Mich.) Gas and Electric Company has been purchased by a syndicate headed by Mr. H. D. Walbridge, of Grand Rapids, Mich. Associated with him are Florence Morgans, Joshua Hill, F. G. Jacobs, F. H. Carroll and Aaron Perry. The reorganized enterprise is to be known as the Pontiac Lighting Company, and its properties are to be bonded in the sum of $300,000. It is understood that the gas plant will be rebuilt.

THE shareholders of the Cincinnati (O.) Gas and Electric Company have formally assented to an increase in the Company's capital, to $29,000,000 from $28,000,000. The income from the new shares will be largely devoted to putting the electric plant in good working condition.

THE Kerr-Murray Mfg. Company, of Fort Wayne, Ind., has successfully completed a storage holder for the Los Angeles (Cal.) Lighting Company. The capacity of the vessel is 500,000 cubic feet, and its construction was carried on under the superintendence of Mr. Fred. W. Freese, of Bloomington, Ind. The completion of the holder was marked by a dinner, which was served in the Del Monte Café, with Mr. Freese as the presiding genius of the feast.

AT the annual meeting of the Omaha (Neb.) Gas Company the following officers were elected: Directors, Frank Murphy, Geo. E. Barker, B. B. Wood, S. T. Bodine and R. Morgan; President, Frank Murphy; Vice-President, Geo. E. Barker; Secretary, G. W. Clabaugh; Treasurer, Isaac Battin; Superintendent, J. N. Klumpp; Engineer, Isaac Battin.

GEGRGE D. STRATTON, a collector in the employ of the Equitable Gas and Electric Company, Utica, N. Y., is charged with larceny. It is said his stealings will go well into the thousands.

THE proprietors of the Springfield (Mass.) Gas Light Company have ordered that the selling rate be put at $1.10 per 1,000 cubic feet gross, prompt payment of accounts to entitle the user to a rebate of 10 cents per 1,000.

THE Consumers Gas Company, of Johnstown, Pa., has placed a mortgage on its plant amounting to $447,000.

AT the annual meeting of the Peoples Gas Light Company, of Cleveland, Ohio, the officers chosen were: Directors, George H. Warmington, Daniel R. Warmington, M. A. Bradley, C. H. Beardsley and I. M. Carrington; President, George H. Warmington; Secretary and Treasurer, Walter K. Fladden; General Manager and Engineer, Daniel R. Warmington.

THE proprietors of the Bridgeport (Conn.) Gas Light Company have authorized and completed an issue of bonds in the sum of $1,000,000. The bonds are to run for 50 years, and are to bear interest at the rate of 4 per cent. per annum.

The Market for Gas Securities.

Queer conditions that, to the unprofessional mind, bore every evidence of artificiality, prevailed in the general share market for the past week. The money lenders put on the screws a bit, and the changing shadows of interest manipulation caused a fair sized slump all over the list early in the week's trading; but the moment the boring was relaxed sharp recoveries were made. Consolidated closed today (Friday) at 215¼ to 216¼. No particular animation in the trading in it was shown at any time during the week. The Company betters its position from a business point of view constantly. The plans for the new plant at Astoria, despite the adverse action by ex-Mayor Van Wyck on the proposed street closings on the official map, are virtually completed.

Brooklyn Union is nominally 212 to 216, and to every "outward" appearance the deal for merging with the Consolidated Company is still in the dim, distant future. However, that event will have to be finally registered. Peoples, of Chicago, was weak, on selling by a speculative party that operates on a wholesale scale—generally to a minus result—between New York and Chicago. Syracuse (N. Y.) bonds are in good demand. Washington (D. C.) gas is 355 bid.

Advertisers' Index.

GAS ENGINEERS. Page

Wm. Henry White, New York City ... 107
Fred. Bredel, Milwaukee, Wis. ... 94
Geo. R. Rowland, New York City ... 105
The Western Gas Construction Co., Fort Wayne, Ind. ... 76
Humphreys & Glasgow, New York City ... 105
American Gas Co., Phila., Pa. ... 94
David Leavitt Hough, New York City ... 104
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 91
Baxter & Young, Detroit, Mich. ... 105
United Gas Improvement Co., Phila., Pa. ... 99
James T. Lynn, Detroit, Mich. ... 104
A. E. Boardman, Brevard, N. C. ... 104
The Jeffrey Manufacturing Co., Columbus, O. ... 102

GAS WORKS APPARATUS AND CONSTRUCTION.

Continental Iron Works, Brooklyn, N. Y. ... 106
Deily & Fowler, Phila., Pa. ... 108
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 104
Stacey Mfg. Co., Cincinnati, Ohio. ... 107
Bartlett, Hayward & Co., Baltimore, Md. ... 105
Davis and Farnum Mfg. Co., Waltham, Mass. ... 104
R. D. Wood & Co., Phila., Pa. ... 106
Isbell-Porter Company, New York City ... 106
Fred. Bredel, Milwaukee, Wis. ... 94
United Gas Improvement Co., Phila., Pa. ... 99
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 91
The Western Gas Construction Co., Fort Wayne, Ind. ... 76
Humphreys & Glasgow, New York City ... 105
American Gas Co., Phila., Pa. ... 94
Logan Iron Works, Brooklyn, N. Y. ... 108
Riter-Conley Mfg. Co., Pittsburgh, Pa. ... 107
Baxter & Young, Detroit, Mich. ... 104
G. Shepard Page's Sons, New York City ... 104
James T. Lynn, Detroit, Mich. ... 104
A. E. Boardman, Brevard, N. C. ... 104
Christopher Cunningham, Brooklyn, N. Y. ... 92
The Jeffrey Manufacturing Co., Columbus, O. ... 102
Quintard Iron Works, New York City ... 90
Chas. Creighton & Son, New York City ... 91
The Connersville Blower Company, Connersville, Ind. 109
Lloyd Construction Co., Detroit, Mich. ... 90

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md. ... 105
United Gas Improvement Co., Phila., Pa. ... 99
Burdett Loomis, Hartford, Conn. ... 106
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 91
The Western Gas Construction Co., Fort Wayne, Ind. ... 76
Humphreys & Glasgow, New York City ... 105
B. E. Chollar, St. Louis, Mo. ... 101

SCRUBBERS AND CONDENSERS.

R. D. Wood & Co., Phila., Pa. ... 106
Continental Iron Works, Brooklyn, N. Y. ... 106
Logan Iron Works, Brooklyn, N. Y. ... 108
Riter-Conley Mfg. Co., Pittsburgh, Pa. ... 107

TAR AND CARBONIC ACID EXTRACTOR.

The Western Gas Construction Co., Fort Wayne, Ind. ... 76

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich. ... 92
American Gas Company, Phila., Pa. ... 94
The Western Gas Construction Co., Fort Wayne, Ind. ... 76

GAS METERS.

John J. Griffin & Co., Phila., Pa. ... 112
American Meter Co., New York and Philadelphia. ... 111
Helme & McIlhenny, Phila., Pa. ... 111
D. McDonald & Co., Albany, N. Y. ... 109
Nathaniel Tufts Meter Co., Boston, Mass. ... 110
Maryland Meter and Mfg. Co., Baltimore, Md. ... 110
Metric Metal Co., Erie, Pa. ... 111
Keystone Meter Co., Royersford, Pa. ... 110
Detroit Meter Company, Detroit, Mich. ... 75

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia. ... 111
John J. Griffin & Co., Phila., Pa. ... 112
D. McDonald & Co., Albany, N. Y. ... 109
Helme & McIlhenny, Phila., Pa. ... 111
Nathaniel Tufts Meter Co., Boston, Mass. ... 110

GAS AND WATER PIPES.

M. J. Drummond & Co., New York City ... 96
R. D. Wood & Co., Phila., Pa. ... 96
Warren Foundry and Machine Co., New York City ... 96
Donaldson Iron Co., Emaus, Pa. ... 96
Christopher Cunningham, Brooklyn, N. Y. ... 92

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., N. Y. City ... 96

GAS TAPPING MACHINES.

George Light, Dayton, O. ... 96
H. Mueller Manufacturing Company, Decatur, Ills. ... 92

GAS COALS.

Perkins & Co., New York City ... 102
Westmoreland Coal Co., Phila., Pa. ... 103
Berwind-White Coal Mining Co., New York and Phila. ... 106

CANNEL COALS.

Perkins & Co., New York City ... 102

CONVEYORS.

The Link-Belt Machinery Co., Chicago, Ills. ... 103
The Western Gas Construction Co., Fort Wayne, Ind. ... 76
The Jeffrey Manufacturing Co., Columbus, O. ... 102

GAS ENRICHERS.

Standard Oil Co., New York City ... 103
The Sun Oil Co., Pittsburgh, Pa. ... 103

COKE CRUSHERS.

C. M. Keller, Columbus, Ind. ... 103
The Jeffrey Manufacturing Co., Columbus, O. ... 102

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, Brooklyn, N. Y. ... 96
The Connersville Blower Company, Connersville, Ind. ... 109

GAS GAUGES.

The Bristol Co., Waterbury, Conn. ... 102

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City 101
Isbell-Porter Co., New York City ... 106
R. D. Wood & Co., Phila., Pa. ... 106

CEMENTS.

C. L. Gerould, Galesburg, Ills. ... 100

RETORTS AND FIREBRICKS.

J. H. Gautier & Co., Jersey City, N. J. ... 100
Adam Weber Sons, New York City ... 100
Laclede Firebrick Mfg. Co., St. Louis, Mo. ... 100
Cyrus Borgner, Phila., Pa. ... 100
James Gardner, Jr., Co., Pittsburgh, Pa. ... 100
Henry Maurer & Son, New York City ... 100
Baltimore Retort and Firebrick Co., Baltimore, Md ... 100
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. ... 100
Brooklyn Firebrick Works, Brooklyn, N. Y. ... 100
Missouri Firebrick Co., St. Louis, Mo. ... 100

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md. ... 105
Fred. Bredel, Milwaukee, Wis. ... 94
J. H. Gautier & Co., Jersey City, N. J. ... 100
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. ... 100
Adam Weber Sons, New York City ... 100
Laclede Firebrick Mfg. Co., St. Louis, Mo. ... 100
Missouri Firebrick Co., St. Louis, Mo. ... 100
S. D. Merton & Co., St. Louis, Mo. ... 100

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Co., New York City ... 106
Continental Iron Works, Brooklyn, N. Y. ... 106
Logan Iron Works, Brooklyn, N. Y. ... 108
R. D. Wood & Co., Phila., Pa. ... 106

CHIMNEY CONSTRUCTION.
Adam Weber Sons, New York City..... 100

INCANDESCENT GAS LAMPS.
Welsbach Company, Gloucester, N.J..... 98
General Gas Light Company, Kalamazoo, Mich..... 91
D. M. Steward Mfg. Co., Chattanooga, Tenn..... 93

BURNERS.
C. A. Gefrorer, Phila., Pa..... 93
Wm. M. Crane Co., New York City..... 93
D. M. Steward Mfg. Co., Chattanooga, Tenn..... 93

LAVA GAS TIPS.
D. M. Steward Mfg. Co., Chattanooga, Tenn 93

STREET LAMPS.
Welsbach Street Lighting Co., New York and Phila..... 98
Thos. T. W. Miner, New York City..... 93

PURIFIERS.
R. D. Wood & Co., Phila., Pa..... 106
Stacey Mfg. Co., Cincinnati, O..... 101

PURIFYING MATERIALS.
Connelly Iron Sponge and Governor Co., New York City 101

VALVES.
Ludlow Valve Manufacturing Co., Troy, N.Y..... 92
R. D. Wood & Co., Phila., Pa..... 106
Continental Iron Works, Brooklyn, N. Y..... 106
The P. H. & F. M. Roots Co., Connersville, Ind..... 95
Isbell-Porter Co., New York City..... 106
The Western Gas Construction Co., Fort Wayne, Ind.... 76
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 104

EXHAUSTERS.
The P. H. & F. M. Roots Co., Connersville, Ind..... 95
Isbell-Porter Company, New York City..... 106
Connelly Iron Sponge and Governor Co., New York City 101
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 104
The Connersville Blower Company, Connersville, Ind... 109

ELECTRICAL APPARATUS.
Wm. Henry White, New York City..... 107

ENGINES AND BOILERS.
The Hazelton Boiler Company, New York City..... 92

PURIFIER SCREENS.
John Cabot, New York City..... 102

GAS STOVES.
American Meter Co., New York and Philadelphia..... 97
Maryland Meter and Manufacturing Co., Baltimore, Md. 110
Keystone Meter Co., Royersford, Pa..... 110
Nathaniel Tufts Meter Co., Boston Mass..... 110
Detroit Stove Works, Detroit-Chicago..... 91

HOT WATER HEATERS.
The Humphrey Mfg. and Plating Co., Kalamazoo, Mich. 91

GASHOLDER TANKS.
J. P. Whittier, Brooklyn, N. Y..... 105

GASHOLDERS.
Bartlett, Hayward & Co., Baltimore, Md..... 105
Continental Iron Works, Brooklyn, N. Y..... 106
Deily & Fowler, Philadelphia, Pa..... 108
Davis & Farnum Mfg. Co., Waltham, Mass..... 104
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 104
Stacey Mfg. Co., Cincinnati, Ohio..... 107
R. D. Wood & Co., Philadelphia, Pa..... 106
Logan Iron Works, Brooklyn, N Y..... 108
Riter-Conley Mfg. Co., Pittsburgh, Pa..... 107

STORAGE TANKS.
Christopher Cunningham, Brooklyn, N. Y..... 92

AUDITORS AND ACCOUNTANTS.
The J. Dobson Good Audit Company, New York City.... 90

INVESTORS.
W. R. Faben Construction Company, Toledo, O.. 91

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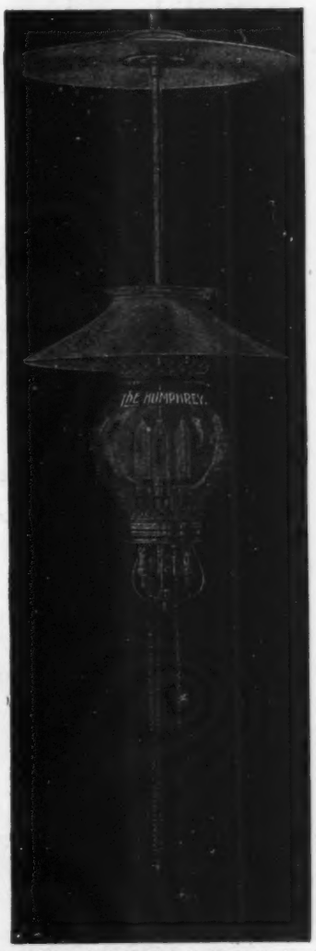

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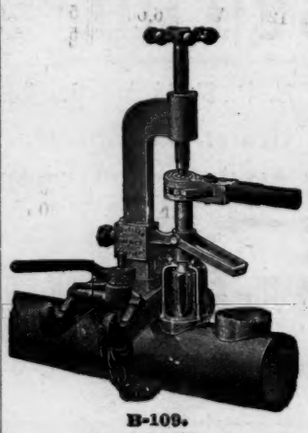

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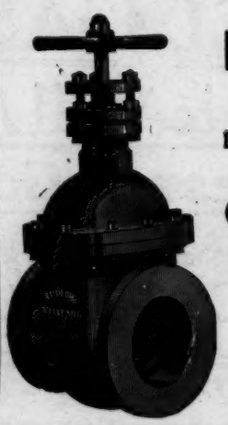

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COAL GAS PLANTS AND GAS APPARATUS.

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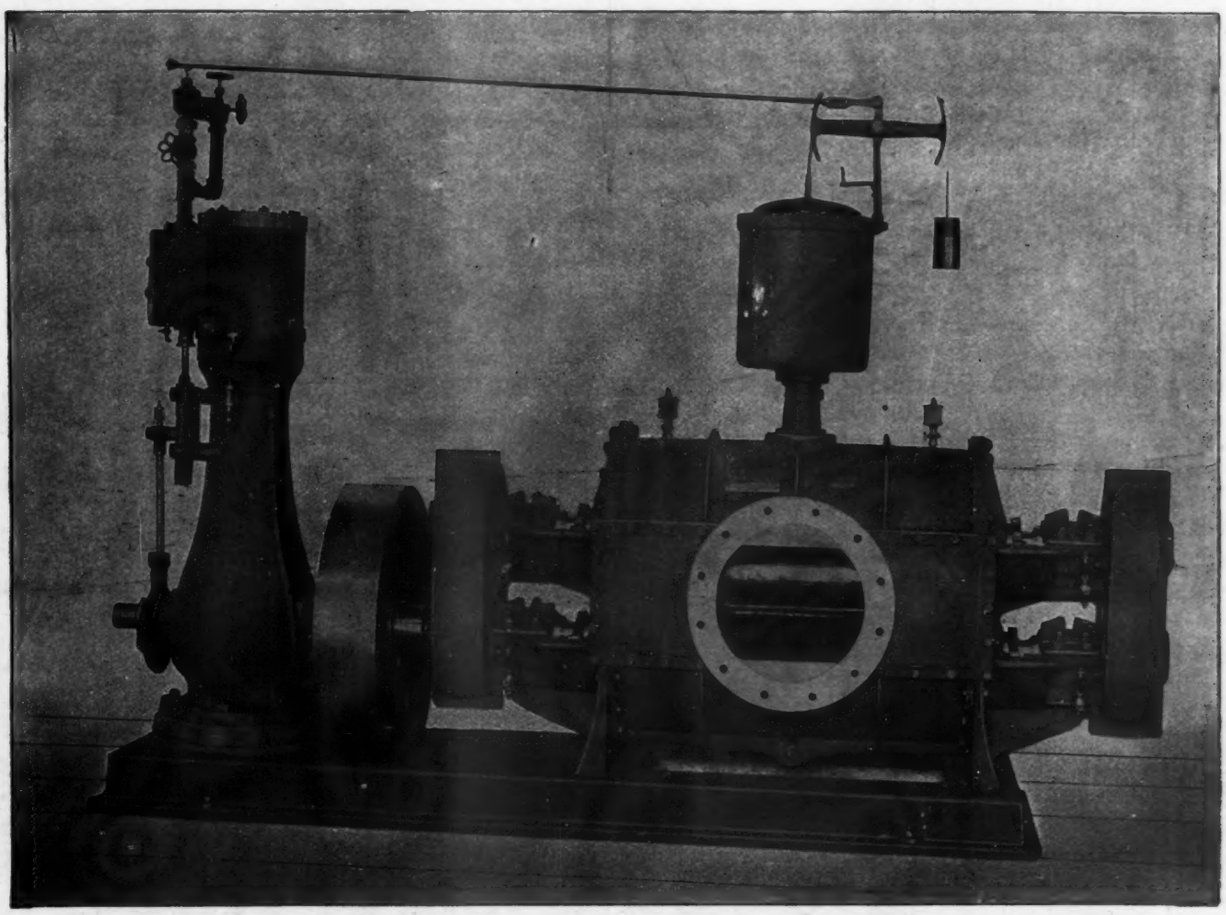

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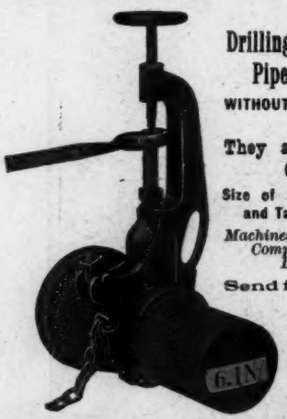

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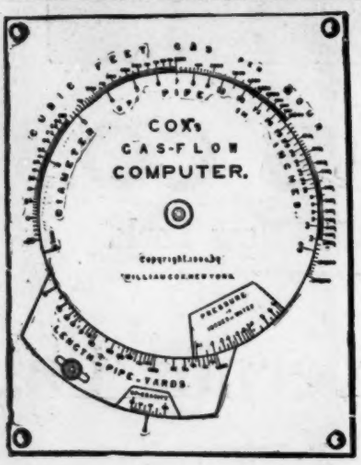

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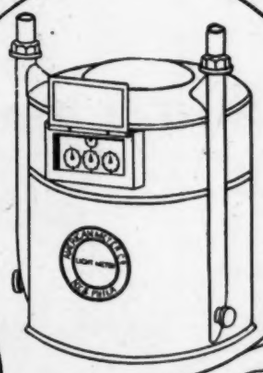

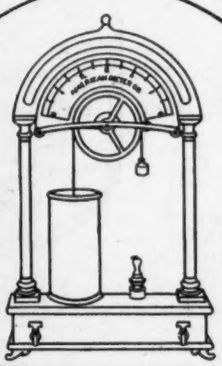

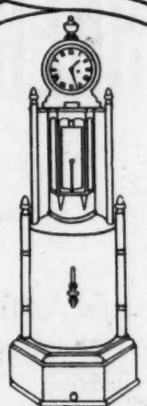

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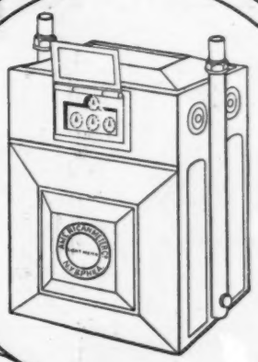
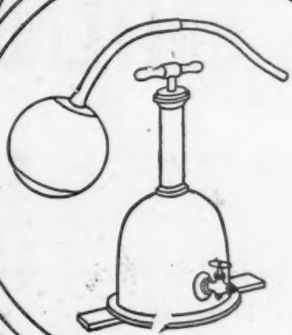
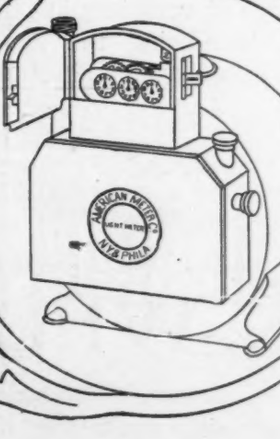






PUBLIC LIGHTING TABLE.

FEBRUARY, 1902.

Day of Week.	Table No. 1. Following the Moon. Date.	Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Sat.	1	5.40 PM	3.20 AM	5.05	6.15
Sun.	2	5.50	4.10	5.05	6.15
Mon.	3	5.50	5.00	5.05	6.15
Tue.	4	5.50	5.40	5.05	6.15
Wed.	5	5.50	6.10	5.10	6.10
Thu.	6	5.50	6.10	5.10	6.10
Fri.	7	5.50	6.10	5.10	6.10
Sat.	8	5.50 NM	6.10	5.10	6.10
Sun.	9	6.00	6.00	5.10	6.10
Mon.	10	6.00	6.00	5.10	6.10
Tue.	11	6.00	6.00	5.10	6.10
Wed.	12	6.00	6.00	5.20	5.55
Thu.	13	10.30	6.00	5.20	5.55
Fri.	14	11.40	6.00	5.20	5.55
Sat.	15	12.40 AM FQ	6.00	5.20	5.55
Sun.	16	1.40	5.50	5.20	5.55
Mon.	17	2.40	5.50	5.20	5.55
Tue.	18	3.30	5.50	5.20	5.55
Wed.	19	4.10	5.50	5.30	5.55
Thu.	20	4.50	5.50	5.30	5.55
Fri.	21	No L.	No L.	5.30	5.55
Sat.	22	No L. FM	No L.	5.30	5.55
Sun.	23	No L.	No L.	5.30	5.55
Mon.	24	6.20 PM	9.20 PM	5.30	5.55
Tue.	25	6.20	10.20	5.30	5.55
Wed.	26	6.20	11.10	5.30	5.45
Thu.	27	6.20	12.10 AM	5.30	5.45
Fri.	28	6.20	1.10	5.30	5.45

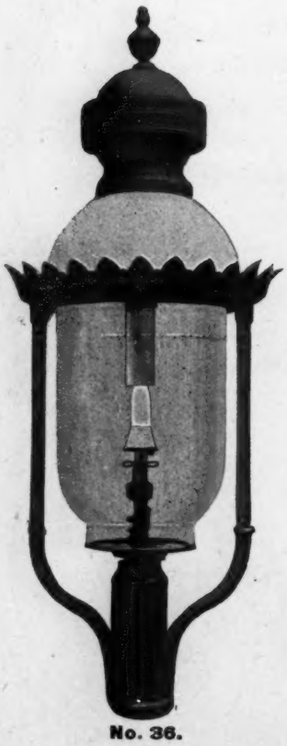
TOTAL HOURS LIGHTING DURING 1902.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	238.30	January	423.20
February	196.20	February	355.25
March	196.20	March	355.35
April	166.40	April	298.50
May	151.40	May	264.50
June	131.10	June	234.25
July	142.40	July	243.45
August	162.00	August	280.25
September	179.00	September	321.15
October	216.30	October	374.30
November	224.10	November	401.40
December	250.00	December	433.45
Total, yr.	2255.00	Total, yr.	3987.45

NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



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Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

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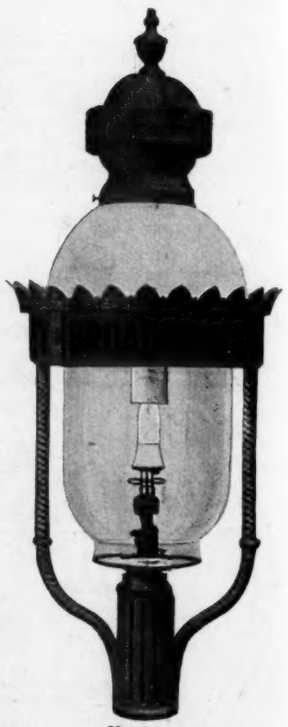

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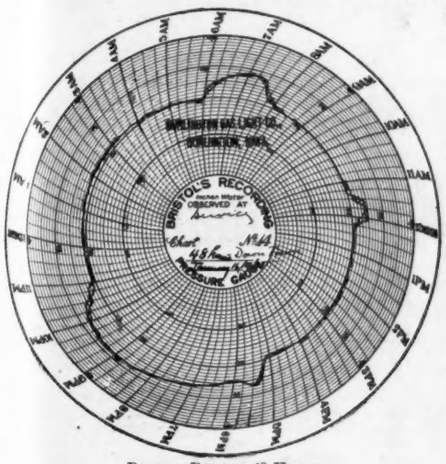

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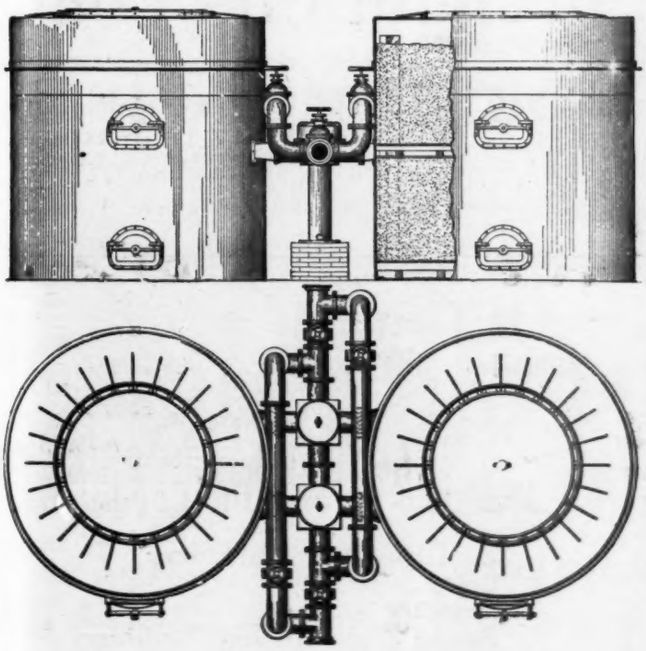

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For Gas Making or
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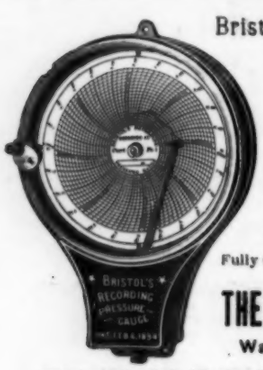

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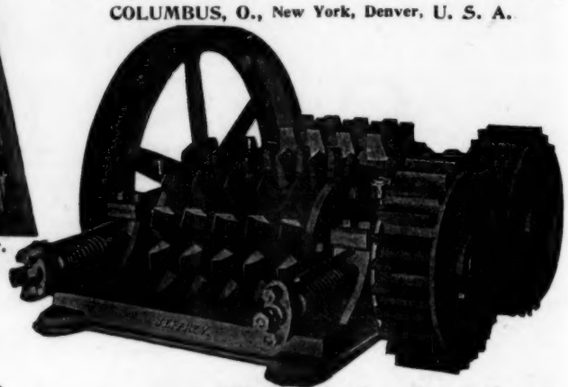

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Strong, Simple, Durable. Will Crush any Size Desired.

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what size of pipe to use to convey any quantity of gas, any distance, with any loss of pressure and any initial or final pressure? Then use

Cox's Gas Flow Computer,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

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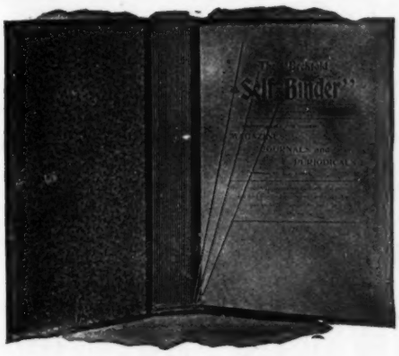

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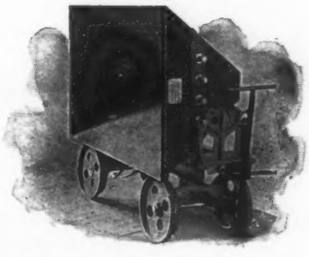

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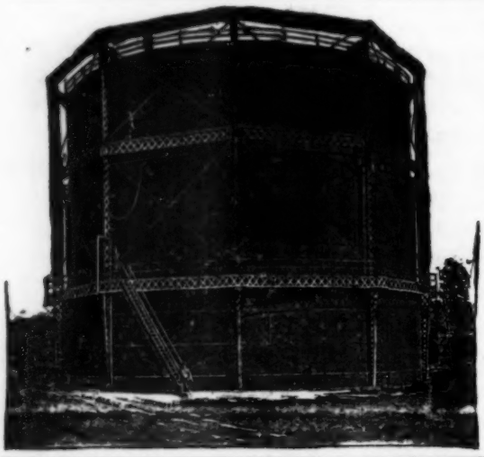

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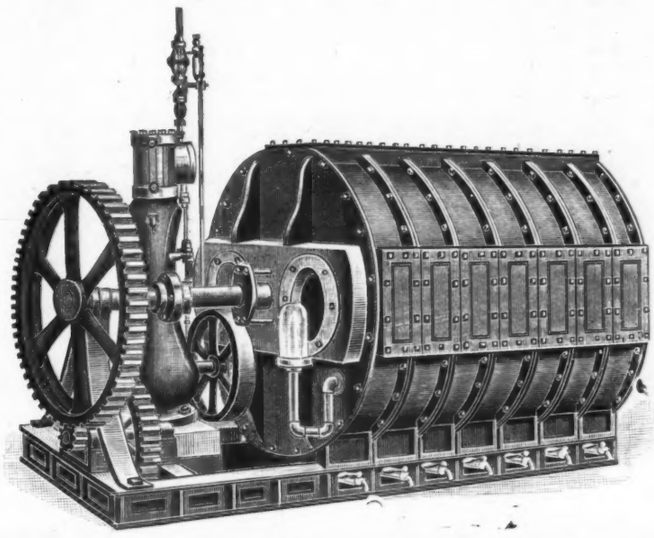

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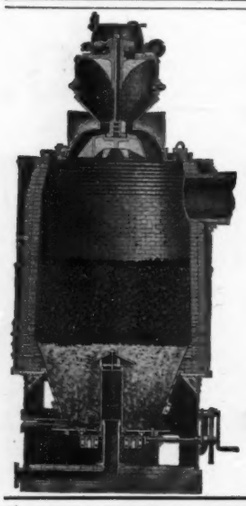

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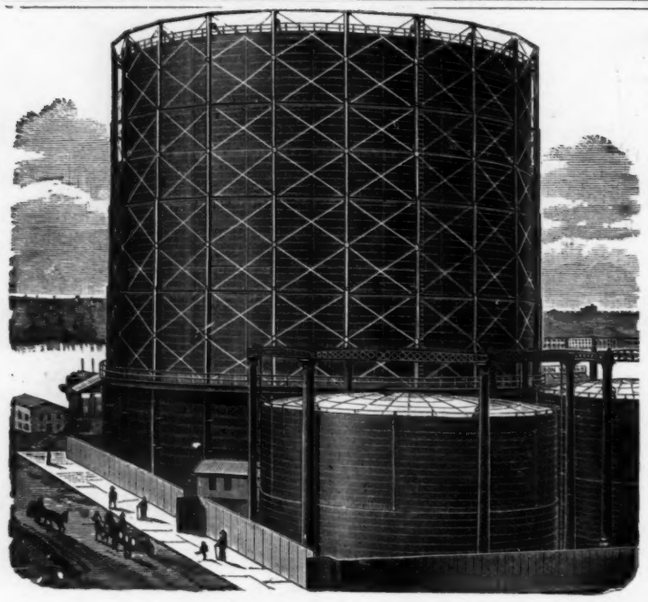

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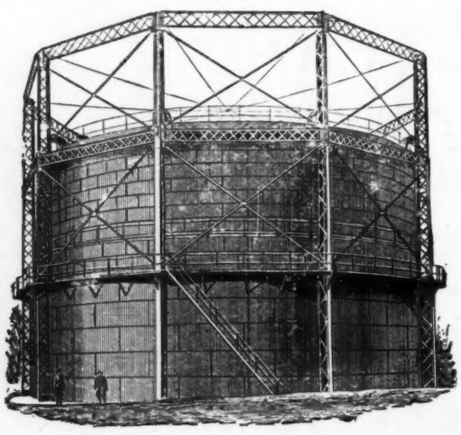

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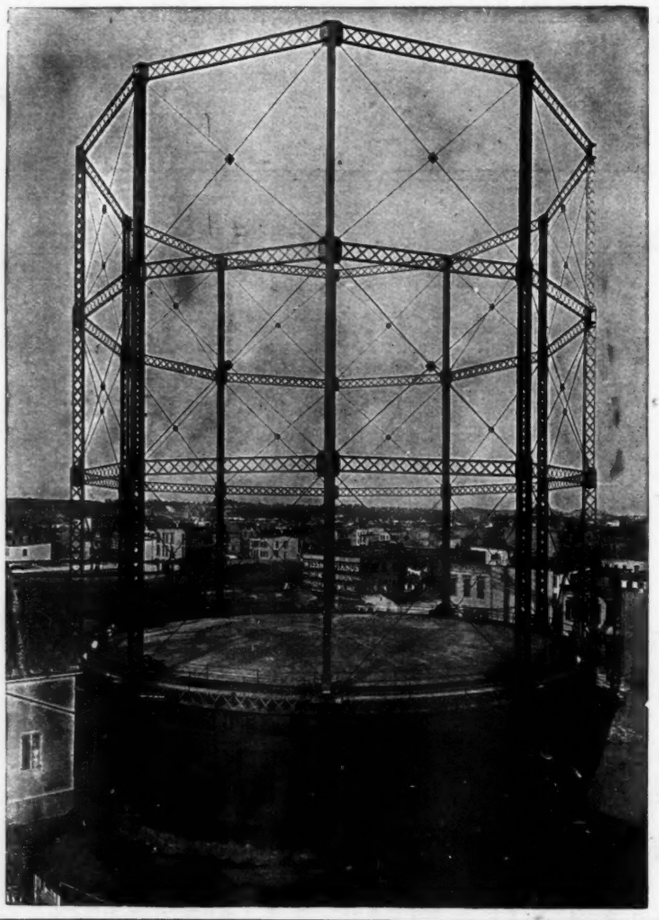

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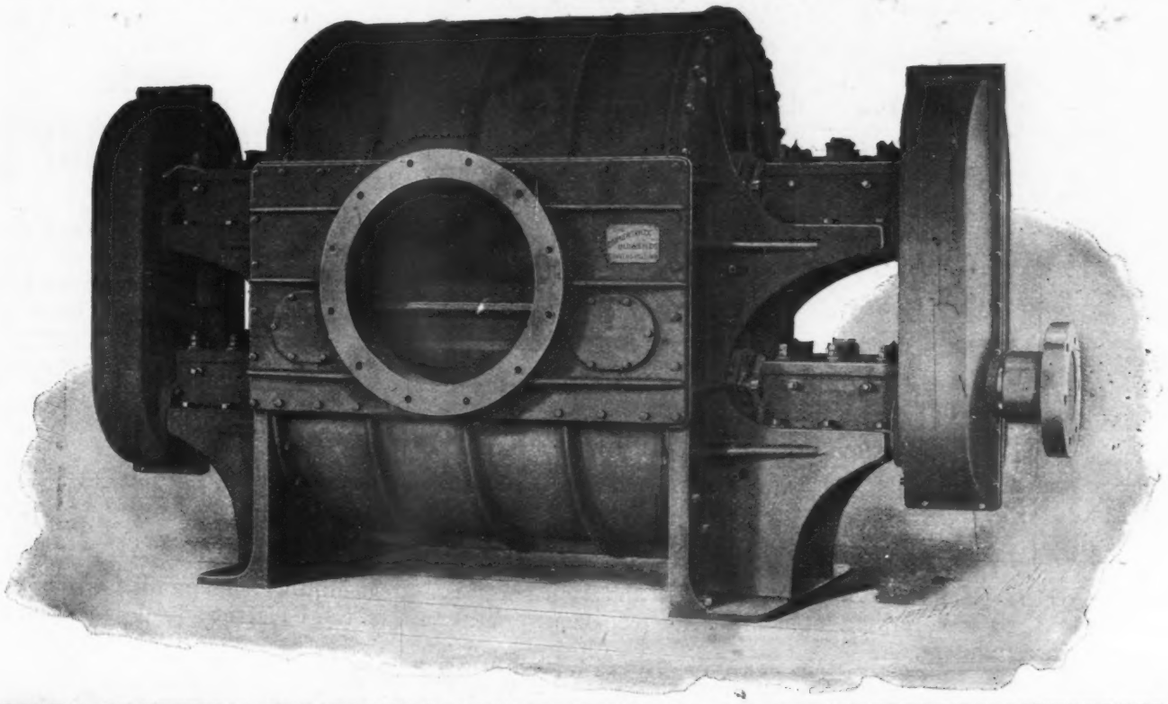

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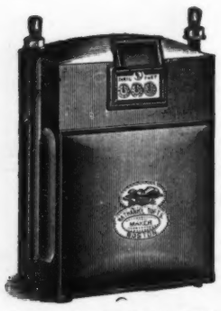

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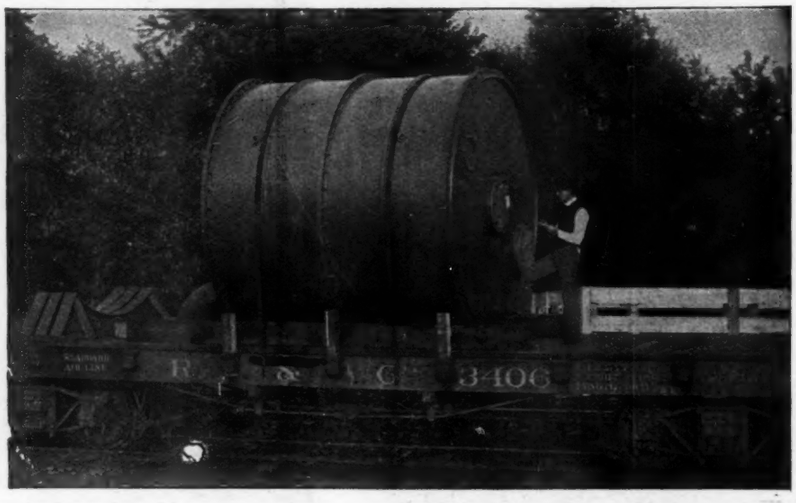

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